

DOCUMENT RESUME

ED 139 753

95

SP 011 046

AUTHOR Henkin, Leon; And Others
TITLE Experimental Investigation of Peer Teaching. Final Report.
INSTITUTION California Univ., Berkeley. Lawrence Hall of Science.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
BUREAU NO BR 3-0435
PUB DATE Apr 75
GRANT NE-G-00-3-0186
NOTE 131p.
EDRS PRICE MF-\$0.83 HC-\$7.35 Plus Postage.
DESCRIPTORS *Educationally Disadvantaged; *Instructional Innovation; *Junior High Schools; Low Income Groups; *Mathematics Instruction; *Peer Teaching; Program Evaluation; *Summative Evaluation
IDENTIFIERS *Alternatives Through Peer Teaching

ABSTRACT

The "Alternatives Through Peer Teaching" program, in which ninth graders teach a special mathematics curriculum to seventh graders, was developed to raise the achievement levels of low socioeconomic level students from educationally disadvantaged backgrounds. This final report details the history of the program, developed by Louis Schell, and evaluates its results. Section One presents the operation and structure used, characteristics of the ninth-grade peer teaching group, selection and screening process for peer teachers, the training program, supervisory procedures, and curriculum content. Section Two (the evaluation) is divided into two parts: (1) the effects of peer teaching on peer-taught students, presenting the subject group and sampling methods, results from the administration of five evaluation instruments, and supplementary results; and (2) the effects of peer teaching on the teachers themselves. The overall analyses indicate that peer teaching, as conducted in this program, produced significantly more beneficial effects on math achievement and ability than one or more of the comparison treatments; no differences between the peer teachers and their ninth-grade controls are found on any of the cognitive tests, though female peer teachers' attitudes and traits relevant to school achievement are significantly more positive than the controls. Statistical data and sample questions from each of the five evaluation instruments are included. The paper concludes with a discussion of the results and a list of references. (MB)

ED139753

Final Report

Submitted to the National Institute of Education

Grants for Research in Education

for period

July 1, 1973 - July 31, 1974

Title of Project: Experimental Investigation of Peer Teaching
NIE Project No. 3-0435, Grant No. NEG-00-3-0186

Applicant Institution: Lawrence Hall of Science
University of California
Berkeley, California 94720

Principal Investigator: Leon Henkin, Professor of Mathematics
Department of Mathematics
769 Evans Hall
University of California, Berkeley
Berkeley, California 94720
(Phone: 642-3077)

Co-Directors: Harriett Amster, Director of Research
Louis Schell, Director of the Program

Research Assistants: Barbara Gross Davis
Deana Dorman Logan

Project Duration: July 1, 1973 to July 31, 1974

Federal Funds Granted: \$100,000

Date of Final Report: April, 1975.

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

SP 011 046

ABSTRACT

The Schell peer teaching program - Alternatives through Peer Teaching - in which ninth graders teach a special mathematics curriculum to seventh graders, was conducted and evaluated during 1973-74. The peer teachers and their students were from low social classes and were students in the same Jr. High Schools in Oakland, California. Peer teachers and math specialists taught the special math curriculum two days a week; exchange teachers were classroom teachers who taught the regular curriculum but exchanged classes two days a week; regular (control) teachers were classroom teachers who taught the regular curriculum on all five days. The major evaluation concerned the cognitive and attitudinal effects of type of teaching upon the seventh graders. The intellectual tests measured mathematical achievement and nonverbal reasoning ability (CTBS, Raven, PMA, and Cattell), and the attitudinal test measured traits relevant to school achievement (You and School).

The analysis focuses on the Pure Sample, which consists of Ss who received the same type of teaching all year and who were tested on the particular instrument in the regular testing sessions both at the beginning and at the end of the school year. The overall analyses in which the males and females are combined, indicate that peer teaching, as conducted in Schell's program, produced significantly more beneficial effects on math achievement (CTBS) and ability (PMA and Raven) than one or more of the comparison treatments. Trends for the Cattell and You and School are consistent with these results, although not significant. *

Analysis of the separate effects for male and female students suggests that the positive effects of peer teaching are more consistent for female students than for males. However, male students are more responsive than females to the type of peer teaching and the sex of the peer teacher. Specifically, males show significantly greater benefit (CTBS) from having two peer teachers than from having only one, and in addition, they show greater benefit (Cattell) from being taught by female than by male peer teachers. Results from the small samples of Ss who switched conditions during the year or took makeup tests on our evaluation instruments are not always consistent with the results for the Pure Sample.

The effect of peer teaching on the ninth-grade peer teachers was analyzed as a secondary part of the study. No differences between the peer teachers and their ninth-grade controls are found on any of the cognitive tests, but the female peer teachers' attitudes and traits relevant to school achievement become significantly more positive than the controls'.

CONTENTS

	Page
Abstract	i
Introduction	1
Section I: The Program (Louis Schell)	4
Introduction	5
History	5
The Comprehensive Program	6
(Alternatives through Peer Teaching)	
The Restricted Program	8
Program Staff	10
Program Operation	11
Program Structure	12
Peer Teachers' Responsibilities	12
The Peer Teaching Course	12
The Regular Teachers' Involvement	12
in the Program	
Peer Teacher Characteristics	16
The Selection-Screening Program	20
The Training Program	22
Goals	22
Motivation for Design	22
Design	23
Ongoing Training	25
Supervision	26
Curriculum	27

	Page
Section II: The Evaluation (Harriett Amster: Assisted by Barbara Gross Davis and Deana Dorman Logan)	32
Part I: The Effects of Peer Teaching on Peer-Taught Students	32
Method	33
Seventh-grade Ss and their Sampling	33
Experimental Design	35
Test Administration	37
Analysis of Data: Overall Plan	38
You and School	42
Selection of Items	42
Scoring and Administration	44
Preliminary Item Analysis	47
Data Analysis	49
Results	51
Total Scores	51
The Six Scales	55
Comprehensive Test of Basic Skills	62
Method	62
Results	62
The Raven	69
Method	69
Results	75
Primary Mental Abilities	78
Method	78
Results	84
Cattell	88
Method	88
Results	92
Supplementary Results	95
Summary of Results	100
Part II: The Effects of Peer Teaching on the Teachers Themselves	106
Discussion	118
References	125

INTRODUCTION

This final report contains two sections. The first section, The Program, describes the way in which the Schell Peer Teaching Program - Alternatives through Peer Teaching - has been conducted to teach mathematics in lower socio-economic status Jr. High Schools in California. The Program describes the operation of the program, the type of teaching which was carried out, and the methods used in the selection and preparation of the peer teachers. The second section, The Evaluation, reports the details of the evaluation of this program.

Part I of the evaluation focuses on the effects of peer teaching on the seventh graders who were being taught mathematics. The study compares the attitudes and cognitive performance of students who learned mathematics under four different conditions for one school year, 1973-74. Part II compares the performance and attitudes of those who served as peer teachers with comparable ninth-grade control Ss.

Part I of the evaluation compares seventh graders who learned mathematics from peer teachers, math specialists, exchange teachers, and regular (control) teachers. The peer teachers and the math specialists taught the special curriculum used in the Schell Peer Teaching Program. The exchange teachers, the peer teachers, and the math specialists taught in the seventh-grade classrooms two days per week. The exchange teachers were regular classroom math teachers who exchanged classrooms two days per week, but taught the regular curriculum when they exchanged classes. The regular teachers taught in their own classes all five days. Thus, in three

of the groups, a regular teacher taught for three days per week and a peer teacher, math specialist, or exchange teacher taught for two days per week. The same teacher taught all five days in the control group.

Five measures were employed to evaluate the effects of peer teaching and they were of two types, attitudinal and cognitive. A composite measure of attitudes relevant to school achievement, You and School, was employed. It consisted of items selected from many different instruments and adapted to form six scales: self esteem, achievement motivation, non-traditional sexism, satisfaction with school, locus of control, and peer teaching evaluation. The intellectual measures were the three scales of the school-administered mathematics achievement test, the Comprehensive Test of Basic Skills, Raven's Progressive Matrices, selected subtests of the Cattell, and the Primary Mental Abilities. The latter three are purported to measure reasoning, concept formation and spatial relations, respectively, on the basis of non-verbal materials.

The major hypothesis at the outset was that students of peer teachers would perform better than students in the other conditions on each of the measures employed. However, from a practical point of view, it seemed hardly likely that students taught by peer teachers would actually outperform those taught by regular teachers, not to mention math specialists. In fact, it seemed reasonable to hypothesize that peer teachers would not show poorer classroom results than regular classroom teachers. Yet, from the point of view of the evaluation methods, it was necessary to test the rather stringent hypothesis that peer-taught Ss would actually show a greater gain during the course of the year than Ss taught by other methods. If the mathematics method were the crucial factor, the peer teachers and

math specialists should produce reliably greater benefit to their students than either type of regular classroom teacher. Only if peer teaching provided some additional benefit to students, should it be more beneficial than teaching by math specialists. The possible benefits of peer teaching due to (a) the age of the peer teachers, their familiarity with the difficulties faced by the learner, enthusiasm, etc., and (b) the special mathematics which they teach, might be offset by a detriment brought about by the alternation of teachers. If peer teaching were beneficial but changing teachers were detrimental, peer teachers should benefit students more than exchange teachers. However, peer teaching might only show beneficial results compared with specialist and regular teaching if alternation is detrimental. Thus, the design of the study provides the possibility of evaluating the effects of the special math curriculum, the effects of being taught by peers rather than adults, and the effect of having two classroom teachers, one two days a week and the other for three days. However, because of limited resources, most of the Ss were assigned either to peer teaching or to regular teaching.

SECTION I: The Program

By Louis Schell

INTRODUCTION

History

The peer teaching program was originally developed to raise the mathematics achievement of students from educationally disadvantaged backgrounds. It was motivated by peer teaching originated by Warren Leffler in William Johntz's Project SEED, and by a peer teaching project organized in 1969-70 by Ross Franco at Roosevelt Jr. High, Oakland. The program itself and the methods of selecting and training peer teachers were designed and developed by Louis Schell. Several pilot studies implemented by him in 1970-71 in the Berkeley and Oakland School Districts suggested that when students with good training and supervision teach entire classes or small groups for long periods of time, 1) their students do at least as well as those taught only by adult teachers, and 2) they reach more students, are more effective, and less expensive to maintain than tutors who deliver comparable results by meeting with students individually.

In 1971-72, the most successful elements of these studies were consolidated to form the program "Alternatives through Peer Teaching". The program gained the support of Professor Leon Henkin and the Committee on Special Scholarships at the University of California, Berkeley, and received funding for the following two years from the Cooperative College--School Science Division of the National Science Foundation.¹ Since then the program has operated, with a significantly broader scope, as an ongoing program in the Oakland School District and, to date, has involved over 5,000 students in grades 4 through 10.

¹Schell, L., Final Project Report on the Program: Project APT - Educational Alternatives through Peer Teaching. NSF-CCSS Grant: NSF-GW-6548, 1974.

The Comprehensive Program - Alternatives through Peer Teaching

Presently the program's normal operation provides educational, counseling, career-training, and dropout-prevention components for students, and an in-service training program for teachers. The educational and counseling components are aimed primarily at the students of the peer teachers, and the career-training and dropout prevention components are aimed primarily at the peer teachers themselves.

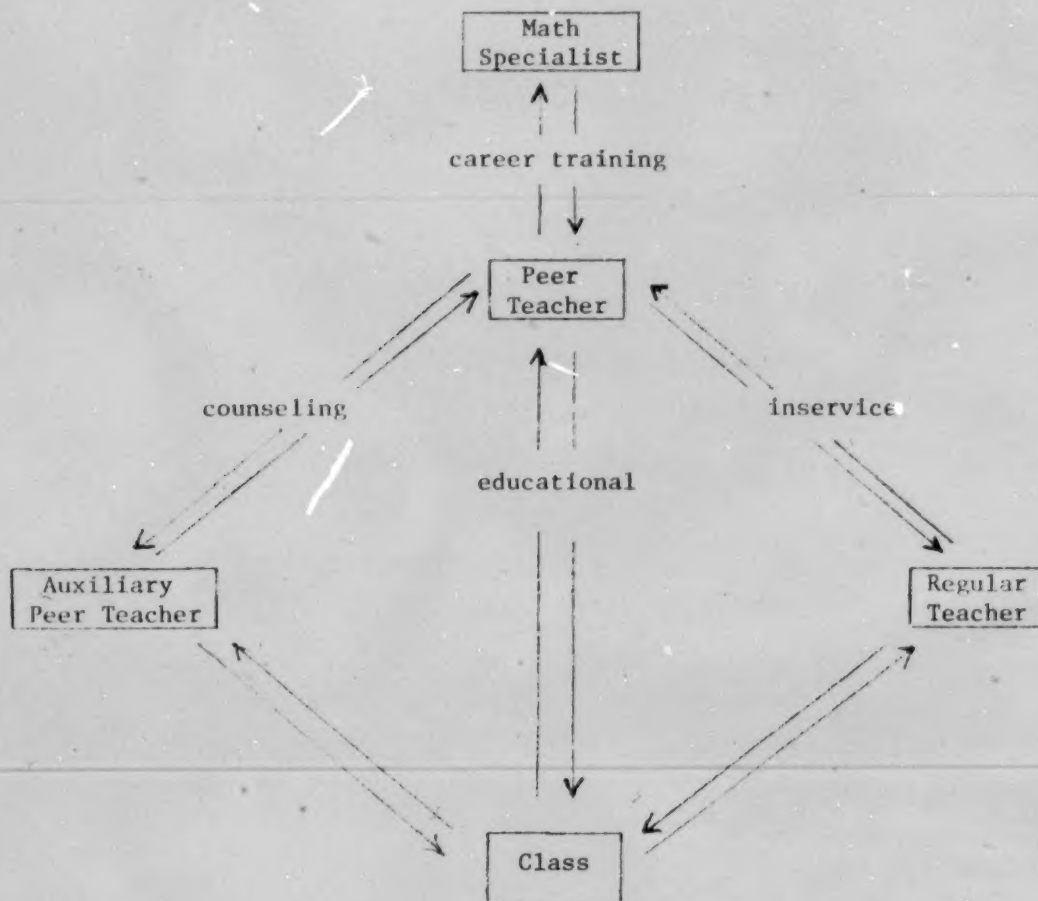
Nearly all of the students who participate in the program come from educationally disadvantaged backgrounds. Many of them question both the educational goals that have been set for them and whether the educational system, as it is, will help them achieve these goals at all. They have negative perceptions of themselves in relationship to society. They are frustrated and poorly motivated, see limited opportunities for any significant payoffs, and have little hope or confidence that they will succeed or be able to control what will happen to them. Strong peer pressures to be deviant often prevent them from doing well in school, while traditional teaching methods, rather than assisting them, often foster and contribute to their alienation and lack of commitment.

To engage these students, the program gives them, in varying degrees, 1) opportunities to use what they know, 2) important, totally legitimate, uncompromised responsibilities for each other's educations, and 3) opportunities to associate or work with successful peer models. Specifically, a peer teaching model was designed to give varied and significant teaching roles to as many students as possible within their classrooms.

The model essentially pivots around peer teachers who are trained to teach arithmetic and conceptual mathematics, and who then share the responsibility with adult teachers for teaching regularly-scheduled math classes.

The peer teachers, in turn, prepare their own students to assume teaching responsibilities in the classes they teach. When involved in this way, their students are called auxiliary peer teachers (XPT's). The peer teachers are supervised by a special trainer and by the teacher in whose class they teach. In turn, they supervise the auxiliary peer teachers. They work closely with the teachers in whose classes they teach, give extra help to their students after school, and assist in training other students to be peer teachers.

The general structure of the model and the relationships that lie at the core of each component are indicated below. Double arrows have been used to emphasize the mutuality of teaching and learning between any two groups.



The Restricted Program

This investigation was designed to evaluate aspects of only one of these components--the educational program. As a result, the following modifications were made on the comprehensive program in order to stabilize both the experimental and control conditions.

- 1) The counseling component was eliminated because it would have provided additional special attention for many students in the peer teaching condition.
- 2) The inservice component was eliminated because it would have affected teachers' behavior in many classes in both the control and experimental conditions.
- 3) The dropout-prevention component was de-emphasized (see section on selection) in order to stabilize the peer teaching condition--i.e., assure that the peer teachers would teach on a regularly-scheduled basis.
- 4) The educational component was modified in order to isolate the effects of peer teaching on classes taught by peer teachers. As a result, the following three facets of the comprehensive model were eliminated: a) Auxiliary peer teachers, b) peer teachers giving extra help to their students after school, and c) experienced peer teachers serving in peer teaching training roles.

Other than the above restrictions, situations that normally occurred in the context of the program were dealt with to preserve the integrity of the students' learning experiences and the integrity of the program itself.

Neither was compromised simply to preserve experimental conditions, nor, in

particular, at the risk or expense of creating negative experiences for particular students. For example, when it was necessary for us or the school administration to transfer a peer teacher from one class to another, or students from one condition to another, it was done. It was felt that the evaluation would be more meaningful if it were to assess peer teaching as the restricted program would normally operate on a day-to-day basis rather than assess peer teaching under classroom conditions that ordinarily would not be maintained. Although there would be risks of complications due to contamination of experimental and control populations, there was the feeling that the findings would reflect more accurately what would happen under normal classroom or administrative conditions and, as a result, be reproducible without placing unreasonable demands on children, teachers, or school administrators.

PROGRAM STAFF

Three math specialists were employed to implement the program. Each had completed at least two years of graduate study in mathematics. All had been trained by Louis Schell in 1971 and had two years' experience in implementing the program. They were Ronald Crossman, Ehsonolah Soofi, and B.F. Wells III.

PROGRAM OPERATION

The peer teaching program operated at three schools in Oakland, California: Roosevelt Jr. High, Lowell Jr. High, and Woodrow Wilson Jr. High. At each school eight peer teachers were selected, trained, and supervised by a math specialist. A different math specialist was assigned to each school. The peer teachers were selected by the first week of October and completed their pre-teaching training early in November. All started to teach immediately after the first battery of tests was given. They taught two days each week for the rest of the school year.

PROGRAM STRUCTURE

Peer Teachers' Responsibilities

The peer teachers taught regularly-scheduled seventh-grade math classes. They did not tutor. They taught by themselves or in teams of two. They taught two days a week for a full class period--approximately one hour each time. They were responsible for managing discipline, giving and grading homework and tests, and assigning grades to their students. These grades were averaged in with the regular teachers' grades.

The Peer Teaching Course

Peer teachers elected "Peer Teaching" as a graded academic course that met daily for a full class period during the school day. Each such class was attended by 4 peer teachers and taught by a math specialist. The first month of the course was devoted entirely to learning the special math curriculum they would teach, and to teacher training. Afterwards, the peer teachers devoted, during each week, two periods to teaching and three periods to class preparation and additional training. For example, they may have spent Monday, Tuesday and Thursday in preparing for their classes and receiving feedback on their teaching, and Wednesday and Friday in teaching. The classes they taught were scheduled during the same time period that their peer teaching course met. They were paid \$3/hour for each class period they taught.

The Regular Teachers' Involvement in the Program

Soon after the school year began, the teachers in whose classes the peer teachers taught met with the math specialist to discuss the general structure of the program and the conditions for its implementation, the

curriculum taught by the peer teachers, the nature of their involvement in the program, and the peer teachers' responsibilities.

1) The method of teaching and general conditions for its success were outlined to the teachers. They were told that the peer teacher, whenever possible, would teach the class as a group and try to involve the students through their discussion of the reasonableness of the answers they gave to the peer teacher's questions. Since this method of teaching required that the class work together, special support and classroom organization was required of teachers who had individualized their instruction and whose students worked essentially by themselves, and special understanding was required of teachers who normally lectured their students without encouraging much discussion among them about what was being taught.

2) The regular teachers were asked to pay careful attention to the general classroom dynamics while the peer teachers taught, and to pay particular attention to the methodology used by the peer teachers. It was explained that these observations would serve throughout the school year as a basis for coordinating the curriculum as the needs of the students changed, as a source of feedback for the peer teachers, and as a means of developing a greater understanding of their students' needs and their ability to deal effectively with them.

3) The regular teachers were asked to participate in the class as students while the peer teachers taught, to work with the peer teacher in

assisting individuals or small groups of students when written work was assigned, and to assist in dealing with particularly difficult classroom or discipline problems.

4) The teachers were asked to meet with the peer teachers and the math specialists outside of class to coordinate curriculum and to discuss methods of presenting material, discipline, general classroom problems and learning difficulties and needs of their students. These meetings were held briefly before or after class, or for longer periods of time before or after school, or during the teacher's conference period. Much of the material covered in these sessions was later reviewed in depth with the peer teacher during preparation sessions.

5) Discipline procedures were discussed and agreed upon by the peer teacher, regular teacher and trainer. They varied from class to class but generally were not permissive. Usually students were asked to raise their hands if they wanted to speak and not leave their seats unless given permission. The peer teachers taught and were encouraged to develop their own styles within this basic framework. Their ability to control their classes seemed to be a function of their spontaneity. Some never said anything about the rules but quietly and forcefully invoked them in the name of respect, order and intelligent behavior when they were broken. The exclamations, "Hey, listen up," or "Be quiet, I can't hear what he is saying," and the way they were said left little doubt in the students' minds of what was expected of them. Others might have said "This is the way it is" and invoked the rules directly. But, in both cases, it was the peer teachers' inherent knack for

saying something right and at the right time and their general manner or the force of their personalities that allowed them to be successful.

However, peer relationships and peer pressures also had their limitations. And so, though the responsibility to keep order was basically given over to the peer teachers on the days that they taught, the regular teachers were asked to be prepared to support or assist them if necessary.

6) Although the curriculum was designed to supplement and complement the curriculum taught by the regular teachers, it was invariably molded to fit the needs of each class. As a result of discussing the curriculum with the teacher, a schedule or timetable for introducing specific topics was agreed upon so that both the peer teacher and regular teacher could maximize the benefits of the other's teaching. For example, it might have been agreed that the regular teacher teach the addition, subtraction and multiplication properties of positive and negative integers in October and November so that the peer teachers, after developing the distributive law, $a(b+c) = ab + ac$ where a, b, c are integers, could introduce in December problems like $-2(-3 + +4)$ without having to first teach the arithmetic properties of signed numbers. Thus, such timing, or curriculum coordination, allowed the introduction of problems like the one above as exercises that reinforced the regular teachers' work, but which did not make it apparent because they were presented within the context of teaching something else.

PEER TEACHER CHARACTERISTICS

Usually, in addition to those who volunteered, the following types of students were recruited by teachers, counselors, principals, and project staff.

- (1) Students who had attitudinal, motivational, or behavioral problems, who were generally uncommitted, alienated or potential dropouts.
- (2) Students who had some motivation to work but whose academic work was marginal--students who might easily fail and not complete school if neglected or who would not fail if given extra attention.
- (3) Underachievers or, in particular, high-potential, low-achieving students--students who could probably enter and complete college.
- (4) Bright students who were bored and losing interest in school.

In general, the program sought to involve students in whom strong positive changes in achievement, behavior and attitudes were expected to have strong positive effects on the behavior and attitudes of other students, on the attitudes and expectations of parents and teachers, and on the academic and social atmosphere of the community and school.

All candidates were screened in a 2-3 week program for their potential to learn and teach mathematics. The screening program was designed to single out those students who had the following characteristics: (1) a strong presence, (2) the ability or potential to teach by asking questions, (3) the ability to learn fast, (4) a good knowledge of basic arithmetic skills, and (5) a relatively high degree of reliability.

The importance of these characteristics has been determined by the following observations.

1. A strong presence

Although many students can be taught techniques that would help them control a class and handle various behavior problems, it is very difficult to prepare and supervise many at one time who do not have a natural ability for doing this. Peer teachers who have a strong presence, by their very existence in front of the class, can often inhibit disruptive behavior, can control it with a glance, or can casually deal with it without making anyone uptight. They demand by their very presence that they be recognized; and they leave no doubt in their students' minds that there is work to be done.

2. The ability or potential to teach by asking questions

Peer teachers who guide their students toward understanding concepts by asking questions invariably teach more skillfully and reach more students than those who do not. Students who have a natural sense for teaching this way consistently demonstrate the ability to listen to their students and place themselves in the position of the learner. They are quick to sense what is bothering students and have the ability to get their students to discover concepts and work out methods of solving problems. They do not feel the urgency or need to tell students answers just because they know them, or go into lengthy explanations that, in a sense, cannot be heard.

In general, peer teachers who have these qualities consistently maintain high attention levels among their students, move their classes at a good pace,

are capable of the spontaneous repartee and questioning that makes a class exciting, and need a minimum of supervision. Often they are able to (1) teach material that they have learned by themselves by reading math books, (2) develop their own curriculum, and (3) originate teaching methods.

3. The ability to learn fast

Peer teachers who learn fast have little difficulty learning new material to teach. Consequently, they rarely have to interrupt their teaching schedule. In addition, their trainer has more time to help them deal with specialized learning problems of their students and more time to help them refine their teaching skills.

4. A good knowledge of basic arithmetic skills

Peer teachers who have the most success in teaching basic arithmetic skills have themselves already mastered them and are confident in their ability to use them. Peer teachers with this mastery can spontaneously deal with many skill problems that arise in class but which they are not specifically taught to handle. In a very natural way they emphasize and explain algorithms they are already comfortable with. By not having to spend time in teaching these skills to the peer teachers, their trainer can devote more time to refining their understanding of the concepts behind the performance of the skills. In addition, there is more time to deal with the problems in teaching these skills and more time to teach how to recognize and deal with specific learning difficulties of students.

5. A relatively high degree of reliability

The peer teachers' effectiveness and impact on their students are related to their ability to teach on a regularly-scheduled basis for long periods of time. It is through regular and continual contact with their students that they are able to (a) develop material in depth, (b) serve as success models, and (c) establish relationships that improve behavior, motivation, attitudes, and expectations. Peer teachers who are always prepared and present to teach clearly have a greater chance of affecting their students.

THE SELECTION-SCREENING PROGRAM

Candidates were invited to try out for peer teaching in the same sense that they would, for example, try out for the basketball team. They were grouped into classes that met before or after the school day and were taught by the math specialist who would later train the peer teachers. They were taught by the very methods they would be trained to use. In addition, they were asked to teach these classes for short periods of time. Many occasions arose where this could happen spontaneously, and some of it was planned with them at meetings arranged partially for this purpose.

These meetings were scheduled during the school day and involved two to six students. Another purpose for them was to test the extent to which the candidates possessed the characteristics mentioned earlier. Following are examples of two activities designed for this purpose:

- 1) The small group is taught by the math specialist for approximately 10-15 minutes. The material might have been taught as fast as possible in order that the trainer could gauge the students' learning speeds. When finished teaching, he asks some of the students to teach selected parts of the material back to him and the other students for 5-15 minutes. The students who teach are encouraged to copy the style of the trainer or to teach using their own style.
- 2) The student is asked to go to the board and teach something he already knows, but something he has not been prepared to do by

the math specialist; for example, how to add fractions with unlike denominators. No specific directions are given the student except that he is encouraged to teach by asking questions, namely, to think of what he wants to say (but not to say it) and then to devise a situation (write something on the board) and ask a question or series of questions that will lead his students to give the very explanation or answer he himself would like to give.

By offering correct, incorrect, or ambiguous answers to the questions asked by the student who teaches, the math specialist is able to appraise the student's spontaneity and comfort in a teaching situation and ability or potential to learn and teach mathematics. Because it has been found that some students can teach small groups well but cannot teach large groups successfully, all the students are asked to teach the large class that meets before or after school, for this condition most approximates the conditions they would be teaching in.

The peer teachers were eventually selected on the basis of their performance and teaching in the small group meetings and in the large math class.

THE TRAINING PROGRAM

Goals

The training program was designed to help the peer teachers become as self-sufficient as possible--to develop their own teaching style while maintaining their spontaneity, and to develop their ability to design and organize materials (Curriculum) and teach with little guidance or supervision.

Motivation for Design

The method of training and specific elements of the training program were motivated by the following observations:

- 1) Notes and teaching demonstrations providing very detailed examples of how particular material could be taught and how specific learning skills and teaching methods could be used, facilitated the peer teachers' learning how to teach and appeared to serve them as references or models when designing, organizing, and teaching new materials.
- 2) Exercises in working through and analyzing all the details of the examples presented to them (in 1 above), appeared to develop the peer teachers' ability to teach the material and to transfer what they had learned to new situations.
- 3) Personal experiences in learning the curriculum and learning how to teach it served to guide the peer teachers' selection of appropriate teaching methods, and to guide their using or adapting these methods to deal with unexpected teaching problems in the classroom.

4) Successful teaching experiences appeared to reinforce the value, effectiveness, and usefulness of the methods learned, and motivated or predisposed the peer teachers to think in terms of and to use these methods again.

5) Practice teaching insured the likelihood that the peer teachers would teach their classes successfully. It developed their perspective and understanding of the material, and their confidence in their ability to teach well.

In short, it appeared that if the peer teachers understood in great detail exactly what was involved in teaching a specific block of material, and if they taught it successfully, then they invariably built up a set of experiences that served as the foundation for their own creative teaching and subsequently established a basis from which they could develop their autonomy.

Design

To provide the required detailed level of understanding of the material, and to insure that they teach successfully, a training program with two major components was designed. In the first component, the peer teachers learn exactly how to teach a model curriculum. In the second component, they learn teaching and learning skills that are exemplified by the very methods used to teach the model curriculum, and they apply these skills to learning and teaching related materials. The first component dominates their training prior to their teaching, and is gradually phased out once they begin to teach. The second component is introduced as a minor theme prior to their teaching, and grows to dominate the ongoing training activities once teaching begins.

The first component of the training program is comprised of the following elements, listed below in the order in which they are introduced to the peer teachers:

1) The peer teachers learn the curriculum. They experience it as students. The curriculum is taught to them in exactly the same way as they will be expected to teach it. Their instructor uses the same methods and techniques that they will be expected to use.

2) After learning the material, they examine what is involved in teaching it. They critically observe portions of the curriculum taught again. They examine the organization and structure of the curriculum and the anatomy of the methods used to teach it. Their instructor serves as a teaching model.

3) They study notes that outline or present in detail how to teach portions of the curriculum and describe, in detail, specific teaching methods.

4) They practice teaching the material, help each other learn how to teach, and play the role of their students vis-a-vis their fellow peer teachers. To a great extent, they learn to teach by copying their instructor.

The elements of the second component are introduced as they are needed to facilitate the peer teachers learning how to teach the model curriculum. These elements may be introduced in any order and are usually first employed in stage 2 of the first component. They are usually introduced in the form of exercises, questions and short speeches. They include the following topics: (1) How to deal with mistakes and wrong answers; (2) How to formulate questions; (3) How to use the board; (4) How to analyze problems; (5) How to

organize material; (6) Patterns; (7) The logic of instruction; and
(8) Explanations.

Every aspect of their training prior to their teaching is intended to provide the peer teachers with (a) personal experiences that reinforce the value and usefulness of the methods they learn, (b) curriculum and teaching models to which they can refer when developing and teaching their own materials, and (c) a deep understanding of what they teach and why they teach in the way they do.

Ongoing training

Once they begin teaching, they are weaned away from detailed and comprehensive preparation and practice sessions, and are given, in stages, increased responsibility for preparing and teaching material without reviewing or practicing it first with their instructor. For a short period of time after they begin to teach, much of their preparation sessions are spent reviewing what will be taught the next day or that week. However, as this review becomes less and less necessary, they spend their time (1) briefly reviewing or checking out their lesson plans for the week's teaching, (2) reviewing their previous day's teaching--getting feedback on their teaching and discussing how they might deal with specific classroom problems, (3) learning and practicing new material, (4) making up their own material and working out methods of presenting it, and (5) refining their teaching methods.

SUPERVISION

In-class supervision was aimed at providing feedback, on-the-job instruction, and teaching assistance.

1) Feedback based on their supervisor's observations was either presented directly in the preparation sessions or incorporated indirectly into the preparation for a following day's teaching.

2) On-the-job instruction was provided by giving teaching demonstrations in the classes the peer teachers taught. Sometimes it was easier or more effective to demonstrate something by teaching these classes than by trying to explain or demonstrate the same thing in the small group preparation sessions.

3) Teaching assistance was usually given if (i) the peer teachers were very confused or seriously confusing or misleading their classes, and (ii) there seemed to be no way by which they could reverse the situation. Usually the peer teachers were given a lot of freedom and time to resolve their own difficulties, correct their mistakes, or re-orient themselves. The point at which the supervisor stepped in was somewhat dependent on his understanding of the peer teacher's psychology and sense of teaching, and on his assessment of how much potential the situation had to demonstrate something to the peer teacher, balanced against the potential risks of letting the peer teacher continue.

THE CURRICULUM

All the peer teachers taught the same conceptually oriented curriculum and used it as a vehicle for introducing remedial and basic skill problems that the regular teachers felt were important for their students to learn and review. The curriculum included a development of the concepts of sequences and series and some of their applications.

The notation $\left\{ f(N) \right\}_{N=1}^K$ $f(1), f(2), f(3), \dots, f(K)$ was introduced

for the representation of a sequence. The concept of a variable was explored and the students' facility in working with sequences of the form

$\left\{ \frac{a}{b} N \pm \frac{c}{d} \right\}_{N=1}^K$ where K is an integer greater than 1 and a, b, c, d are integers,

was developed. The students were introduced to the notion of assigning numbers to variable constants and the idea of substitution with respect to variables. Thus, in assigning $b=1, c=0, a=9$, and $K=5$, the students

generate the sequence $\left\{ 9N \right\}_{N=1}^5$. In expanding the sequence as N ranges

from 1 to 5, the students generated the products: $9 \times 1, 9 \times 2, 9 \times 3, 9 \times 4, 9 \times 5$, which they then computed. If, for example, the regular teacher discovered that after spending a great deal of time teaching the multiplication tables, a number of students still could not remember them, the teacher might ease off the topic but ask the peer teacher to create problems like the above example, in the hope that these students would work on their multiplication while it is presented in a different context. Thus, the peer teacher, in the context of teaching the more general concept of sequences, would

include more problems of the form $\left\{ aN \right\}_{N=1}^8$ where a is an integer constant,

than he might ordinarily have done.

Students were asked to find the general terms of simple sequences like

3, 6, 9, 12, 15, . . . , namely $3N$, where $N=1,2,3, \dots$

or of compound sequences like

1, 3, 5, 7, 9, . . . , namely $2N-1$, where $N=1,2,3, \dots$

and

$\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \frac{15}{16}, \dots$, namely $\frac{2^N-1}{2^N}$, where $N=1,2,3, \dots$

Through examples like these the peer teachers had the opportunity to focus their students on computational problems, arithmetic concepts and the conceptual problems of recognizing patterns and formulating abstract representations of these patterns. It was through kindling their students' interest in the latter that the peer teachers were often able to get their students to work on their computational skills.

The following examples will illustrate this point.

1) Where a is a negative integer, expanding the sequence $\left\{ aN \right\}_{N=1}^8$

serves as an exercise in the multiplication of positive and negative integers.

2) Where $a \geq 433$, expanding the sequence $\left\{ aN \right\}_{N=33}^{37}$ serves as an

exercise in the multiplication of large numbers.

3) Where b is an integer, expanding and computing the terms of

$\left\{ \frac{N}{b} + \frac{1}{b} \right\}_{N=1}^5$ serves as an exercise in adding fractions with like denom-

inators, while expanding and computing the terms of $\left\{ \frac{b}{N} + \frac{b}{4} \right\}_{N=2}^3$ serves

as an exercise in adding fractions with unlike denominators and an exercise in the subsequent reduction of fractions.

4) In trying to establish the relationship between the sequences

$$\left\{ \frac{2}{3} N \right\}_{N=1}^4 \quad \text{and} \quad \left\{ \frac{2N}{3} \right\}_{N=1}^4$$

the students first had to expand the sequences and then examine the relation between the same numbered terms. Thus, in comparing

$$\left\{ \frac{2}{3} N \right\}_{N=1}^4 = \frac{2}{3} \times 1, \frac{2}{3} \times 2, \frac{2}{3} \times 3, \frac{2}{3} \times 4$$

$$\text{and} \quad \left\{ \frac{2N}{3} \right\}_{N=1}^4 = \frac{2 \times 1}{3}, \frac{2 \times 2}{3}, \frac{2 \times 3}{3}, \frac{2 \times 4}{3}$$

students were led to review and get practice in using the algorithm for multiplying a fraction by a whole number in order to establish

$$\left\{ \frac{2}{3} N \right\}_{N=1}^4 \equiv \left\{ \frac{2N}{3} \right\}_{N=1}^4$$

5) Or, in trying to motivate the distributive law, the sequences

$$\left\{ (a + b)N \right\}_{N=K}^{K+1} \quad \text{and} \quad \left\{ aN + bN \right\}_{N=K}^{K+1} \quad a, b \text{ integers}$$

were compared. For example, the students may be asked to expand

$$\left\{ (5 + 6)N \right\}_{N=2}^4 \quad \text{yielding} \quad (5+6) \times 2, (5+6) \times 3, (5+6) \times 4$$

$$\begin{array}{l} \text{to compute each term to get} \quad 11 \times 2, \quad 11 \times 3, \quad 11 \times 4 \\ \text{and} \quad 22, \quad 33, \quad 44 \end{array}$$

The students are then asked to expand

$$\left\{ 5N + 6N \right\}_{N=2}^4 \quad \text{yielding} \quad 5 \times 2 + 6 \times 2, 5 \times 3 + 6 \times 3, 5 \times 4 + 6 \times 4$$

$$\begin{array}{l} \text{to compute each term to get} \quad 10 + 12, \quad 15 + 18, \quad 20 + 24 \\ \text{and} \quad 22, \quad 33, \quad 44 \end{array}$$

In comparing terms it is seen that

$$(5+6) \times 2 = (5 \times 2) + (6 \times 2) \text{ and}$$

$$(5+6) \times 3 = (5 \times 3) + (6 \times 3) \text{ etc.}$$

and thus the generalization

$$(a+b)N = aN + bN.$$

So much for these examples.

The concept of a series was explored as an extension of the concept of sequences. Problems of the form

$$\sum_{N=1}^k \frac{a}{b} N + \frac{c}{d}$$

were introduced in much the same way that parallel problems of the form

$$\left\{ \frac{a}{b} N + \frac{c}{d} \right\}_{N=1}^K \text{ were introduced.}$$

Some simple properties and applications of finite and infinite series were explored. They included:

1) Sequences of partial sums

$$2) \quad a \sum_{N=1}^k f(N) = \sum_{N=1}^k af(N), \quad a \in \mathbb{R}$$

$$3) \quad a \sum_{N=1}^k f(N) + a \sum_{N=1}^k g(N) = a \sum_{N=1}^k [f(N) + g(N)], \quad a \in \mathbb{R}$$

4) The general decomposition of series leading to

$$\sum_{N=1}^k f(N) = \sum_{N=1}^1 f(N) + \sum_{N=2}^2 f(N) + \dots + \sum_{N=k}^k f(N)$$

$$5) \quad \sum_{N=1}^k N = \frac{k(k+1)}{2}$$

$$6) \sum_{N=1}^k 2N-1 = k^2$$

$$7) \sum_{N=1}^k 2N = k(k+1)$$

Numerous specific examples and drill problems accompanied the development of these properties or formulas.

SECTION II: The Evaluation

By: Harriett Amster

Assisted by: Barbara Gross Davis
and
Deana Dorman Logan

PART I: The Effects of Peer Teaching
on Peer-Taught Students

METHOD

Seventh-grade Subjects and their Sampling:

The Ss were seventh-grade students in 34 classrooms from four Junior High Schools in the Oakland Unified School District, Oakland, California. Specifically, eleven classrooms from Lowell Junior High School, eight classrooms from Roosevelt Junior High School, nine classrooms from Wilson Junior High School, and six classrooms from Claremont Junior High School participated and were assigned to conditions as shown in Table 1.

The total number of Ss who were in the 34 participating classrooms (n=865 according to school records) was much larger than the actual number of Ss for whom we had any data at all (n=736). Thus, the school records contain the names of 135 students for whom we have no information. The actual number of Ss within treatment conditions for whom we obtained data is shown in Table 2. However, the number of Ss employed within the analysis of a particular measure is smaller than the number which appears in the composite because of missing data for that particular measure. If all Ss with any missing data or any measure had been excluded from the analyses, the sample would have been decimated. Thus, the samples were separately defined for each of the five instruments employed in the evaluation and consisted of those Ss who had taken both pre- and posttests on that particular measure. Further information in regard to the samples is provided in the section on experimental design.

Table 1

Composite of Number of Ss by Condition According to our Records¹

	Treatment				
	Type of Teaching				
	Peer Teacher	Math Specialist	Exchange Teacher	Regular Teacher	Total
Pure Samples	260	74	53	249	636
Switch Samples	41	16	4	39	100
Total No. of <u>Ss</u>	301	90	57	288	736
No. of Classes	14	4	2	14	34

¹ Number of Ss available for specific comparisons deviates from the figures above due to missing data on one or both tests of the measure in question.

Experimental Design

The experimental design for the major study, the evaluation of the effects of peer teaching on the seventh-grade students taught, was basically a 4 x 2 factorial in which the variables were Treatments and Sex. The Treatments were Peer Teaching, Math-Specialist Teaching, Teacher Exchange, and Regular Teaching [Control].¹ However, because of the great variance among classrooms, the pure sample to be described below was not analyzed as a two-way factorial design, but rather as two one-way factorial designs. In the first analysis, the 34 classrooms provided 34 levels in a one-way factorial. In the second analysis, the eight cells of the Sex by Treatment Design provided the eight levels of the one-way analysis. On the basis of these overall analyses, a priori hypotheses were tested using Dunn contrasts (1961).

The original plan involved the assignment of each classroom to one of the four conditions. The classrooms were to remain intact and assigned to the same condition for the entire year. However, due to circumstances beyond our control, some of the Ss were switched from one condition to another in midyear. Since there was no known basis for selection of Ss to be switched, we are assuming that the switched group was a random selection of the entire sample. However, we processed the data separately for those Ss who remained in the same condition for the entire year (Pure Sample) and those who were switched in midyear (Switched Sample). The Switched Sample was analyzed in accordance with the treatment condition which was assigned for the second term of the school year because Ss were exposed to the treatment for a longer period in the second term than in

¹Regular Teaching is called the Control treatment throughout the text although students were not randomly assigned to the various treatment conditions. The treatments specify the manner in which the Ss were taught, and the dependent variables refer to their performance.

the first and because the second treatment would have been more recent at the time of the test.

Because of poor classroom attendance, it was necessary to give makeup tests for those who had not attended class on the date of regular testing. Makeup tests were administered to groups which differed from the normal classes and, in general, the rapport which was established during the makeup testing was unavoidably poor. Because this additional source of variance might have been confounded with conditions in an unknown way, the makeup Ss were treated as separate groups in the analysis of the data. The composite sample described in Table 1 is not broken down for the makeup samples because their particular composition varied for each analysis.

For each of the five instruments, the following four samples were treated separately in the data analysis:

1. Pure Sample. These Ss had taken both pre- and post-tests during the regular sessions, for the dependent variable in question, and had remained in the same condition for the entire year. (In a few cases, the Ss had been switched from one classroom to another within the same experimental condition.) This is the important group in this evaluation.

2. Switch Sample. These Ss switched from one condition to another in midyear and were assigned to their second-term condition for purposes of data analysis, regardless of their original assignment.

3. Pure Makeup Sample. These Ss took at least one makeup test but remained in the same condition for the school year.

4. Switch-Makeup Sample. These Ss took at least one makeup test and switched conditions between terms.

Test Administration

Except for the Comprehensive Test of Basic Skills, all tests used in the evaluation were administered by the research assistants on this project. They were aided in most cases by high school students who had been peer teachers in prior years and who were trained by us for this assistance. It was believed that these former peer teachers would aid us in establishing rapport with Ss.

Tests were administered in early October, 1973, and in May, 1974. The peer teachers had not yet begun to teach the classes to which they were assigned before the October administration. However, peer teaching began almost immediately following the administration of pretests.

The battery of tests was administered in two testing sessions. You and School was administered before the others. The subsections describing the individual tests make note of the particular instructions employed for the test discussed in that subsection.

Analysis of Data

Overall Plan for Evaluation

A. The Pure Sample

The major analyses were conducted on the pure sample. The dependent variables were processed using the basic methods described below:

1. You and School: Total Score (Dunn contrasts)
2. You and School: Six Factors (Multivariate Dunn contrasts)
3. Raven Progressive Matrices: Total Correct (Dunn contrasts)
4. Primary Mental Abilities Spatial Orientation Subtest: Right minus Wrong (Dunn contrasts)
5. Comprehensive Test of Basic Skills: Total scores for the Arithmetic Computation, Concepts, and Applications subtests (Multivariate Dunn contrasts)
6. Comprehensive Test of Basic Skills: Total Score (Dunn contrasts)
7. Cattell: Total Correct (Dunn contrasts).

Analyses were carried out for each of the above dependent variables on a) the pretest scores, b) the posttest scores, and c) the difference scores. The pretest data was analyzed to establish the difference between conditions which existed at the outset. If no significant differences among classrooms or conditions existed prior to the treatments, it would be reasonable merely to process the posttest data to determine the significance of the differences between experimental conditions. If, however, significant differences among classrooms were found in the pretest analyses, the difference scores were employed to evaluate the effects of the conditions.

Multivariate analyses were employed in the cases in which more than one obtained score was derived from the same test, otherwise univariate analyses were conducted on each of the dependent variables. Because there was a possibility that the classrooms were significantly different irrespective of experimental condition, we wished to preserve the classroom as a unit of analysis. The Dunn Contrasts permitted tests of the differences between conditions maintaining the classroom as a unit, and also provided a relatively sensitive test of the a priori hypotheses which we had formulated. In using this approach we abandoned consideration of schools as a unit of analysis. Thus, two types of analysis were performed on each dependent variable, analysis by classroom ($n=34$) and analysis by condition [$(n=4) \times \text{sex } (n=2)$]. For the analysis by classroom, the following differences between treatments were evaluated by Dunn Contrasts:

- a) Peer Teaching vs. Math Specialist
- b) Peer Teaching vs. Teacher Exchange
- c) Peer Teaching vs. Regular (Control) Teaching
- d) Peer Teaching + Math Specialist vs. Teacher Exchange + Controls

All tests were made to control the significance level at .05.

For the other type of analysis, the classroom as a unit was abandoned because the number of cases would have been too drastically reduced in many of the cells. More specifically, it was not even possible to obtain at least 3 Ss in each subgroup when the classrooms were divided according to sex. Therefore, for the second analysis, males and females within each of the four conditions constituted the unit of analysis. The following comparisons of Ss between conditions were tested through use of Dun Contrasts:

- a) Male vs. Female Students within the Peer Teaching condition
- b) Male vs. Female Students within the Math Specialist condition
- c) Male vs. Female Students within the Exchange Teaching condition

- d) Male vs. Female Students within the Control (Regular Teaching) condition.
- e) Female Students: Peer Teaching vs. Math Specialist + Exchange Teaching
- f) Female Students: Peer Teaching + Math Specialist vs. Exchange Teaching + Control
- g) Male Students: Peer Teaching vs. Math Specialist + Exchange Teaching
- h) Male Students: Peer Teaching + Math Specialist vs. Exchange Teaching + Control

Comparisons a) through d) consider the sex differences within conditions, while comparisons e) through h) consider differences between conditions within each sex. Comparisons a) through d) were treated as one family, consisting of all the data in the particular analysis. Comparisons e) and f) were treated as a family consisting of all the females in the sample, and comparisons g) and h) were treated as a separate family consisting of all the males in the sample. All tests were performed to control the significance level at .05.

B. Switched Sample and the Two Makeup Samples

Because of the small number of cases, no analysis by classroom was possible on these samples. The analyses of the Switched Sample and Pure Makeup Sample were conducted using a [Condition x Sex] design, as described above for the Pure Sample. However, since the number of cases was small, the Teacher Exchange was merged into the control providing six groups. Dunn's Contrasts were employed as above to make the following comparisons for the Switched and Pure Makeup Samples:

- a) Peer Teaching vs. Math Specialist
- b) Peer Teaching vs. Control
- c) Female Students: Peer Teaching vs. Math Specialists
- d) Female Students: Peer Teaching vs. Control
- e) Male Students: Peer Teaching vs. Math Specialist
- f) Male Students: Peer Teaching vs. Control

The first two comparisons, a) and b), involve differences between conditions and as such comprise a family consisting of the entire sample. Comparisons c) and d) comprise a family consisting of all females in the sample, and comparisons e) and f) comprise a family consisting of all males in the sample. As above, all comparisons were made to control the significance level at .05.

For the Switched Makeup Sample, which was the smallest, only two levels were analyzed, the peer-taught group and all the others combined and pooled over sex. For the Switched Makeup Sample, these two groups were contrasted. For the Switched Makeup, Dunn's Contrasts were employed to test the hypothesis that the peer-taught group was significantly different from the others.

YOU AND SCHOOL

Selection of Items

Personality characteristics, attitudes, and cognitive styles, relevance to performance in school and susceptibility to type of instruction were compiled from various sources and combined into a single instrument called herein, You and School (Table 2). The original tests from which the items were drawn were purported to measure achievement motivation (Jackson, 1965), attitudes toward school (original items), locus of control (Clifford & Cleary, 1972; Nowicki & Struckland, 1974; Coleman, 1966), and self-concept (Coopersmith, 1967; Coleman, 1966).

Two of the investigators selected items from the original batteries which seemed suitable for our purposes and our Ss. Each item selected was believed to reflect one of the four original scales, named above, or to reflect sex-role traditionality. Thirty-seven items which met the criteria for both investigators were employed in the You and School test, and three items designed to evaluate peer teaching per se were added.

The forty items were arranged into booklets entitled You and School (reproduced in part on next page). Items were presented as statements to be rated on a five-point scale instead of in their original formats. The five-point scale was Strongly Agree, Agree, Don't Know, Disagree, and Strongly Disagree. As can be seen by comparison of the You and School items with their original versions, many of the items were rewritten to communicate better to our subject population. We were assisted in the determination of communicability and in the rewriting by three high school students who had been peer teachers in one of the Jr. High Schools in which the study was conducted. Their familiarity with our subject population enabled them to help us clarify the items and choose phrases which should be meaningful to our Ss.

You and School

Name _____ Date _____

School _____ Teacher _____

Directions: Below are 40 statements about school and you. Mark how you feel about each statement. If you strongly agree with the statement, put a mark under Strongly Agree. If you agree with the statement, put a mark under Agree. If you don't know or are unsure how you feel, put a mark under Don't Know. If you disagree with the statement, put a mark under Disagree. If you strongly disagree with the statement, put a mark under Strongly Disagree. Make sure you mark one answer for each question.

	STRONGLY AGREE	AGREE	DON'T KNOW	DISAGREE	STRONGLY DISAGREE
School is important to me.	<u>5</u>	<u>4</u>	<u>3</u>	<u>2</u>	<u>1</u>
I often get discouraged in school.	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Taking tests is just a lot of guessing for me.	<u>1</u>	_____	_____	_____	_____
I keep working on a problem after others give up.	<u>5</u>	_____	_____	_____	_____
Guys should be the best students in math.	<u>1</u>	_____	_____	_____	_____
I wish this class would be taught the same way again next year.	<u>5</u>	_____	_____	_____	_____
I am as smart as the other kids.	<u>5</u>	_____	_____	_____	_____
I think I deserve the grades I get.	<u>5</u>	_____	_____	_____	_____
I never work harder than I have to.	<u>1</u>	_____	_____	_____	_____
Girls should try to hide how smart they are because it just turns guys off.	<u>1</u>	_____	_____	_____	_____
The best person to teach you is someone close to your own age.	<u>5</u>	_____	_____	_____	_____
I'm not doing as well in school as I'd like to.	<u>1</u>	_____	_____	_____	_____
A high grade is just a matter of luck for me.	<u>1</u>	_____	_____	_____	_____
I often try to do things that are hard for me.	<u>5</u>	_____	_____	_____	_____

Scoring and Administration

The 40 items were arranged in one random order in a booklet administered in a group testing situation. The format is shown on the preceding sample page. Points were assigned to each item such that one or five points were assigned to the strongly agree category, depending on the direction of the item. Five points was assigned for the favorable direction of each item. The sample page which follows illustrates the scoring for the first two items. The maximum total score on the 34 items used in the scoring was 170, while the midpoint value of 3 given to all 34 items would yield a score of 102.

Table 2

Attitudinal Scales showing Judged
Classification of Items from You and School¹

I. Self Esteem and Expectation of Success and Failure

- 2. I often get discouraged in school.
- 7. I am as smart as the other kids.
- 12. I'm not doing as well in school as I'd like to.
- 16. I'm afraid to tell my teacher when I don't understand things.
- 22. I'm pretty happy with myself.
- 32. Sometimes I feel that I just can't learn.
- 37. I find it very hard to talk in front of the class.

II. Achievement Motivation

- 4. I keep working on a problem after others give up.
- 9. I never work harder than I have to.
- 14. I often try to do things that are hard for me.
- 19. I want to do things a little better than anyone else does.
- 24. I don't care if I'm the best or not.
- 29. I don't do any more studying than I have to.
- 1. School is important to me.
- 27. I'm doing the best work I can.

III. Non-Traditional Sexism

- 5. Guys should be the best students in math.
- 10. Girls should try to hide how smart they are because it just turns guys off.
- 15. A girl would feel strange going out with a guy who was smarter than she was.
- 20. A guy would feel strange going out with a girl who was smarter than he was.
- 25. It's natural that guys who are good in school will not be liked by the girls.
- 30. It's natural that girls who are good in school will not be liked by the guys.

IV. Liking for School

- 21. Many of my classes each day are a waste of time.
- 31. Schools should really be called prisons.
- 36. I like school better than my friends do.

V. Locus of Control

- 8. I think I deserve the grades I get.
- 13. A high grade is just a matter of luck for me.
- 17. I would do better in school if teachers didn't go so fast.
- 23. When I get a low grade, it's because the teacher doesn't like me.
- 28. When I get a bad grade, I feel it's my fault.
- 33. When I don't work hard my grades get worse.
- 35. Good luck is more important than hard work for success.
- 39. When I do something wrong there's nothing I can do to make it right.
- 18. When I really want a better grade than usual I can get it.
- 38. I'm surprised when I get a good grade.
- 40. People like me don't have much of a chance to be successful in life.

VI. Peer Teaching Evaluation

- 11. The best person to teach you is someone close to your own age.
- 6. I wish this class would be taught the same way again next year.
- 26. Math will never be one of my favorite subjects.

¹
Deleted items: 3. Taking tests is just a lot of guessing for me.

34. People think I'm lazy.

— Reversed weighting

Preliminary Item Analysis

After the pretest data were collected but prior to analyzing the effects of the treatments, a factor analysis was conducted.¹ Twelve factors with eigen values greater than 1 resulted. However, together they accounted for only 16% of the variance within the battery, and therefore, we decided to use the five rationally-defined, substantive scales reproduced below which we had used as a basis for selecting the items at the outset.

In order to categorize the items more systematically than had been done originally, we obtained four graduate students in Psychology or Educational Psychology to serve as independent judges. They were given the 37 items (excluding Scale VI) which had been originally categorized into the five scales and instructed to categorize each item into the one scale into which it fit more clearly. If it was multiply classifiable or if it was unclassifiable, they were asked to categorize it as ambiguous. Thus, the judges classified each item into one of the categories which represented the first five scales of Table 2 and an "ambiguous" category for items which were classifiable into more than one category or were unclassifiable into the given categories.

Thirty-one of the 37 items were classified into the same category by at least three out of the four judges. The remaining six items were re-rated, this time requiring the four judges to assign each item to two of the above categories, and using an unclassifiable category in addition. On this basis, four of the six items were assigned to one of the five scales if all four of the judges agreed on any one assignment. Two items were discarded. Table 2 shows the categories and the 35 items assigned to them. In addition, it shows the three items which were originally selected as specific to evaluating

¹Available on request.

the effect of peer teaching and the two discarded items. Items were scored in the positive or negative direction to conform to the direction expressed by the scale name such that high scores indicated a favorable direction.

The correlations between the items of the You and School Questionnaire were low; only three correlations were greater than +.30: 3 and 13; 13 and 38; 20 and 15 and the correlations were .31, .32, and .31 respectively. The printout of the interitem correlations as well as the results of the (unused) factor analysis with varimax rotation is available on request. The correlations and the factor analysis were conducted with the entire pretest sample.

Data Analysis: You and School

There were 457 Ss in the Pure Sample, distributed as shown in Table 3. In the Switched, Makeup Pure, and Makeup Switch Samples there were 66, 62, and 23 Ss, respectively.

The You and School questionnaire was processed in two ways. First, the total score on the questionnaire was used as a dependent variable, and second, the score on each of the six scales was analyzed using a multivariate analysis. These two analyses for the different samples (Pure, Makeup, etc.) varied in minor detail because of the differences in sample size. The total score was processed for all samples; the scale scores were processed for the Pure and Switch conditions only. The treatment conditions were considered separately only for the Pure Sample; they were grouped for the other analyses as described above.

The total score on You and School reflects generally constructive, favorable attitudes and traits which would be expected to relate to a positive approach toward school. More specifically, the total score reflects the total positive score on the following scales with Sexism (#3) excluded:

1. Self esteem, expectation of success and failure, self confidence (+ for high self esteem, expectation of success and self confidence, - for low self esteem, expectation of failure, and low self confidence)
2. Achievement motivation and achievement orientation (+ for high motivation, - for low motivation)
3. Non-traditional sexism (+ for low sexism, - for high sexism)
4. Liking for school (+ for like school, - for dislike school)

5. Locus of control (+ for internal locus of control, - for external locus on control)
6. Peer Teaching Evaluation (+ for positive evaluation, - for negative)

• Note on the Significance Levels Reported in the Tables of Results:

Superscripts are used to denote the means which differ significantly, $p < .05$. The particular superscript does not denote the p level. Rather, it denotes that a particular mean differs from another with the same superscript. The most extensive tables in the set consider the analyses of each of the dependent variables in the Pure Sample. Six analyses are reported in each of these Tables; two each for the posttest, pretest, and difference score (posttest minus pretest). The one analysis directly compares the eight Sex by Condition means reported in the tables. The other analysis compares the four means of the 34 classrooms which, when grouped, yield the means for the totals which appear in the right-hand column of each of the tables concerning the Pure Sample. Differences between means from different analyses were not evaluated.

Results: You and School

Total Scores

Total scores for You and School were analyzed for the Pure Sample (Table 3), Makeup Pure Sample, Switched Sample, and Makeup Switched Sample. The only analysis on which significant effects were obtained was the overall analysis of the Switched Sample. Though small and not significant, the trends of the means for the Pure Sample (Table 3) showed a consistently greater increase in positive attitudes and traits in the peer-taught group ($n=194$) compared with all other groups ($n=263$). However, curiously enough, the effect was reversed in the Switched Sample with the peer-taught groups ($n=25$) showing a decline in favorableness ($-.07$) over the year, compared with the control group ($n=28$) which showed an increment ($.16$), $p < .05$. The same trends were apparent for both sexes although the effect was significant ($p < .05$) only for the overall data.

Table 3

Mean Score per Item for the
Total You and School for the Pure Sample, by Condition (34 items)

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>	(Interpreted)		(Interpreted)		(Interpreted)	
Peer Teaching (14)	3.52	(89)	3.47	(105)	3.49	(194)
Specialist (4)	3.46	(28)	3.40	(28)	3.43	(56)
Peer Teaching + Specialist (18)	3.50	(117)	3.45	(133)	3.49	(250)
Teacher Exchange (2)	3.47	(23)	3.57	(6)	3.49	(29)
Control (14)	3.50	(105)	3.43	(73)	3.47	(178)
Teacher Exchange + Control (16)	3.49	(128)	3.44	(79)	3.47	(207)
Total		(245)		(212)		(457)
<u>PRETEST</u>						
Peer Teaching (14)	3.44	(89)	3.37	(105)	3.41	(194)
Specialist (4)	3.46	(28)	3.41	(28)	3.44	(56)
Peer Teaching + Specialist (18)	3.45	(117)	3.38	(133)	3.41	(250)
Teacher Exchange (2)	3.42	(23)	3.53	(6)	3.45	(29)
Control (14)	3.45	(105)	3.41	(73)	3.43	(178)
Teacher Exchange + Control (16)	3.45	(128)	3.42	(79)	3.43	(207)
Total		(245)		(212)		(457)
<u>POST - PRETEST</u>	(Not Interpreted)		(Not Interpreted)		(Not Interpreted)	
Peer Teaching (14)	.08	(89)	.09	(105)	.08	(194)
Specialist (4)	.00	(28)	-.01	(28)	-.01	(56)
Peer Teaching + Specialist (18)	.06	(117)	.07	(133)	.07	(250)
Teacher Exchange (2)	.04	(23)	.04	(6)	.04	(29)
Control (14)	.05	(105)	.02	(73)	.04	(178)
Teacher Exchange + Control (16)	.05	(128)	.02	(79)	.04	(207)
Total		(245)		(212)		(457)

The Ss in the Switched Samples were grouped according to their treatment in the second half of the year. Thus, the Ss who showed the largest gains were categorized as Teacher Exchange and Control Ss although in fact they were primarily peer taught during the first half of the year. It is unfortunate that You and School was not re-tested at the outset of the second term in order to assess the students' level of favorableness prior to the outset of their second term treatment. However, despite this lack of information, an intriguing possibility suggests itself: that peer teaching produces a delayed effect on attitudes. The striking fact is that the absolute level of the posttest mean for the Teacher Exchange and the Control Ss in the Switched Sample ($n=28$) (3.65) is higher than that for the Pure Sample (3.49). The other means for the two samples do not differ by nearly so great an amount, the means for the peer-teaching condition were lower in the Switched Sample.

The Makeup Pure Sample also shows the trend for the peer-taught groups ($n=24$) to show a smaller decline ($-.04$) than the other groups ($n=38$) ($-.05$); all groups in this sample showed a decline during the year.

All of the means for the Makeup Switched Sample were low. However, the trend of the means was similar to that for the Switched Sample in that the Peer Teaching group showed a slight decline in attitude favorableness ($n=9$) ($-.006$) over the year as compared with the others ($n=14$) ($-.015$).

In general, the makeup groups showed the same trends as the groups which were tested in the regular classrooms although the makeup means tended to be slightly lower. Although the Switch and Pure Samples showed contrasting effects, only the Pure Sample received a stable, known treatment condition; also it was more than seven times as large as the Switched Sample. Therefore,

it must be concluded that the teaching condition did not affect students' traits and attitudes relevant to school achievement significantly when they remained in the same condition for the year.

The Six Scales of You and School

The Pure and Switched Samples were analyzed with respect to differences between the sexes within conditions and differences between conditions as hypothesized in the method section. The differences between conditions were very small and no significant differences were obtained for any of the scales. Inspection of the means for the Pure Sample (Tables 4 through 9) indicates that the peer-taught Ss tended to show a more positive change from the pretest to the posttest than the other groups on the Locus of Control Scale (V) and, except for the Specialist and Teacher Exchange conditions, on the Peer Teaching Evaluation Scale (VI). In addition, it is rather shocking that in all conditions, Liking for School and a positive evaluation of Peer Teaching declined over the school year. In the Specialist condition, Achievement Motivation also declined. It is possible that this decline could be due to the students having been subjected to an unusual amount of testing. Only two weeks prior to taking our tests, they had completed a battery of achievement tests administered by the school district. In addition, it is possible that the students were anxious to go on vacation by the time of the posttest and were therefore not favorably inclined toward school. In addition, the means on the Sexism scale were noticeably lower than the means on any other scale, indicating highly traditional sex-role attitudes in our particular sample.

Table 4

You and School:
Mean Scores on the Self Esteem Scale (I) for the Pure Sample (7 items)

CONDITION	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	3.21	(89)	3.27	(105)	3.24	(194)
Specialist	3.23	(28)	3.32	(28)	3.28	(56)
Teacher Exchange	3.30	(23)	3.24	(6)	3.29	(29)
Control	3.13	(105)	3.29	(73)	3.20	(178)
<u>PRETEST</u>						
Peer Teaching	3.15	(89)	3.23	(105)	3.19	(194)
Specialist	3.11	(28)	3.25	(28)	3.18	(56)
Teacher Exchange	3.25	(23)	2.98	(6)	3.19	(29)
Control	3.10	(105)	3.17	(73)	3.13	(178)
<u>POST - PRETEST</u>						
Peer Teaching	.07	(89)	.04	(105)	.05	(194)
Specialist	.12	(28)	.07	(28)	.09	(56)
Teacher Exchange	.05	(23)	.26	(6)	.09	(29)
Control	.03	(105)	.12	(73)	.07	(178)

Table 5

You and School:
Mean Scores on the Achievement Motivation Scale (II) for the Pure Sample (8 items)

CONDITION	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	3.14	(89)	3.09	(105)	3.11	(194)
Specialist	3.00	(28)	3.11	(28)	3.06	(56)
Teacher Exchange	3.26	(23)	3.38	(6)	3.28	(29)
Control	3.06	(105)	3.09	(73)	3.07	(178)
<u>PRETEST</u>						
Peer Teaching	3.03	(89)	3.16	(105)	3.10	(194)
Specialist	3.15	(28)	3.15	(28)	3.17	(56)
Teacher Exchange	3.08	(23)	3.10	(6)	3.09	(29)
Control	3.05	(105)	3.04	(73)	3.05	(178)
<u>POST - PRETEST</u>						
Peer Teaching	.11	(89)	-.08	(105)	.01	(194)
Specialist	-.15	(28)	-.04	(28)	-.11	(56)
Teacher Exchange	.18	(23)	.27	(6)	.20	(29)
Control	.01	(105)	.05	(73)	.02	(178)

Table 6

You and School:
Mean Scores on the Sexism Scale (III) for the Pure Sample (6 items)

CONDITION	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	1.12	(89)	1.24	(105)	1.18	(194)
Specialist	1.07	(28)	1.25	(28)	1.16	(56)
Teacher Exchange	1.04	(23)	1.17	(6)	1.07	(29)
Control	1.24	(105)	1.27	(73)	1.25	(178)
<u>PRETEST</u>						
Peer Teaching	1.05	(89)	1.21	(105)	1.14	(194)
Specialist	1.14	(28)	1.27	(28)	1.21	(56)
Teacher Exchange	1.06	(23)	1.25	(6)	1.10	(29)
Control	1.08	(105)	1.08	(73)	1.08	(178)
<u>POST - PRETEST</u>						
Peer Teaching	.07	(89)	.03	(105)	.04	(194)
Specialist	-.07	(28)	-.02	(28)	-.04	(56)
Teacher Exchange	-.02	(23)	-.08	(6)	-.03	(29)
Control	.16	(105)	.19	(73)	.17	(178)

Table 7

You and School:
Mean Scores on the Liking for School (IV) for the Pure Sample (3 items)

CONDITION	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	3.40	(89)	3.46	(105)	3.43	(194)
Specialist	3.01	(28)	3.68	(28)	3.35	(56)
Teacher Exchange	3.26	(23)	3.50	(6)	3.31	(29)
Control	3.50	(105)	3.50	(73)	3.51	(178)
<u>PRETEST</u>						
Peer Teaching	3.43	(89)	3.74	(105)	3.59	(194)
Specialist	3.12	(28)	4.06	(28)	3.59	(56)
Teacher Exchange	3.29	(23)	3.85	(6)	3.40	(29)
Control	3.58	(105)	3.60	(73)	3.59	(178)
<u>POST - PRETEST</u>						
Peer Teaching	-.03	(89)	-.28	(105)	-.16	(194)
Specialist	-.11	(28)	-.38	(28)	-.24	(56)
Teacher Exchange	-.03	(23)	-.35	(6)	-.09	(29)
Control	-.08	(105)	-.10	(73)	-.08	(178)

Table 8

You and School:
Mean Scores on the Locus of Control Scale (V) for the Pure Sample (11 items)

CONDITION	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	3.67	(89)	3.80	(105)	3.74	(194)
Specialist	3.64	(28)	3.66	(28)	3.65	(56)
Teacher Exchange	3.74	(23)	3.85	(6)	3.76	(29)
Control	3.73	(105)	3.74	(73)	3.73	(178)
<u>PRETEST</u>						
Peer Teaching	3.49	(89)	3.58	(105)	3.54	(194)
Specialist	3.42	(28)	3.59	(28)	3.51	(56)
Teacher Exchange	3.62	(23)	3.89	(6)	3.68	(29)
Control	3.57	(105)	3.58	(73)	3.57	(178)
<u>POST -PRETEST</u>						
Peer Teaching	.18	(89)	.22	(105)	.20	(194)
Specialist	.22	(28)	.07	(28)	.14	(56)
Teacher Exchange	.12	(23)	-.04	(6)	.08	(29)
Control	.16	(105)	.16	(73)	.16	(178)

Table 9

You and School:
Mean Scores on the Peer Teaching Evaluation Scale (VI) for the Pure Sample (3 items)

CONDITION	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
Peer Teaching	2.99	(89)	2.62	(105)	2.79	(194)
Specialist	3.19	(28)	2.79	(28)	2.99	(56)
Teacher Exchange	2.80	(23)	3.00	(6)	2.85	(29)
Control	2.82	(105)	2.82	(73)	2.82	(178)
<u>PRETEST</u>						
Peer Teaching	3.08	(89)	2.83	(105)	2.94	(194)
Specialist	3.14	(28)	2.99	(28)	3.07	(56)
Teacher Exchange	2.94	(23)	3.17	(6)	2.99	(29)
Control	2.99	(105)	2.97	(73)	2.98	(178)
<u>POST - PRETEST</u>						
Peer Teaching	-.09	(89)	-.21	(105)	-.14	(194)
Specialist	.05	(28)	-.20	(28)	-.08	(56)
Teacher Exchange	-.13	(23)	-.17	(6)	-.14	(29)
Control	-.17	(105)	-.15	(73)	-.16	(178)

COMPREHENSIVE TEST OF BASIC SKILLS

Method

Since the CTBS was administered by the schools under unknown conditions, we did not conduct makeup tests. Thus, there were only two samples for the CTBS, Pure and Switched Samples, which were processed separately in a manner parallel to that employed for You and School. As shown in Table 10, the Pure Sample consisted of 471 Ss; the Switched Sample, 71 Ss; there were no makeup samples. The total score on the CTBS and the three component scores, Computation, Concepts, and Applications, were analyzed separately. CTBS grade equivalent scores were used for the analyses. The three component scores were analyzed with a multivariate technique in which the multivariate msw was employed in the Dunn Contrasts used to evaluate the differences between sex and condition. The analyses on all samples were of the same form as those for You and School. The four treatment groups were compared for the Pure Sample, while only three were employed for the Switched Sample. For the Switched Sample, The Teacher Exchange and Control conditions were combined, but the Peer Teaching and Specialist conditions were independently analyzed for both samples.

Results

Pure Sample: Total Score.

Analyses were conducted for the pretest, posttest, and difference scores. The means in Table 10 show that, unfortunately, on the pretest the peer-taught Ss had significantly higher total scores in grade equivalent ($\bar{X}=5.35$) than the

Teacher Exchange Ss (5.29), and the peer-taught math-specialist-taught Ss were significantly higher than the others, 5.29 and 5.04, respectively. For this reason we will not consider the posttest analysis, but rather will rely on the analysis of the difference scores. The analysis of the Pure Sample indicated that those Ss given the Peer Teaching treatment showed a significantly greater gain (.97) over the course of the year than those Ss assigned to the Specialist (.00) and Teacher Exchange (.19) conditions. The former were not, however, superior to those in the control condition. However, the within-sex comparisons revealed that the advantage of peer teaching was to the female Ss, and not to the males, in terms of math achievement. Although the superiority of the gain shown by peer-taught female Ss was not significantly higher than the gain shown by female Ss in other conditions, the trends were all in that direction. For the male Ss, however, the Teacher Exchange and Control difference scores were in the reverse direction, and moreover, males in the Teacher Exchange and Control conditions combined showed a significantly greater gain than those in the Peer Teaching and Specialist condition combined.

Possibly, the greater gain of the female peer-taught Ss was not significant because the female Ss had the highest scores at the outset, and for this reason might have been subject to a ceiling effect.

Table 10

Mean Total Scores for the Three Scales of the Comprehensive Test of Basic Skills
for the Pure Sample, by Condition

CONDITION (# CLASSES)	Females	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
	(Not Interpreted)		(Not Interpreted)			
Peer Teaching (14)	6.55 ^{ab}	(86)	6.10	(93)	6.33 ^{fg}	(179)
Specialist (4)	5.33	(31)	4.86	(34)	5.06 ^f	(65)
Peer Teaching + Specialist (18)	6.23	(117)	5.77	(127)	5.99	(244)
Teacher Exchange (2)	4.20 ^a	(27)	4.66	(9)	4.32 ^g	(36)
Control (14)	6.22	(109)	6.28	(82)	6.24	(191)
Teacher Exchange + Control (16)	5.82 ^b	(136)	6.12	(91)	5.94	(227)
Total (34)		(253)		(218)		(471)
<u>PRETEST</u>						
Peer Teaching (14)	5.51 ^q	(86)	5.20	(93)	5.35 ^s	(179)
Specialist (4)	5.28	(31)	4.97	(34)	5.11	(65)
Peer Teaching + Specialist (18)	5.45 ^r	(117)	5.14	(127)	5.29 ^t	(244)
Teacher Exchange (2)	4.16	(27)	3.92	(9)	4.13 ^s	(36)
Control (14)	5.24	(109)	5.20	(82)	5.21	(191)
Teacher Exchange + Control (16)	5.03 ^{qr}	(136)	5.07	(91)	5.04 ^t	(227)
Total (34)		(253)		(218)		(471)
<u>POST - PRETEST</u>						
	(Interpreted)		(Interpreted)			
Peer Teaching (14)	1.04	(86)	.90	(93)	.97 ^{de}	(179)
Specialist (4)	.05	(31)	-.11	(34)	.00 ^d	(65)
Peer Teaching + Specialist (18)	.78	(117)	.63 ^c	(127)	.70	(244)
Teacher Exchange (2)	.04	(27)	.73	(9)	.19 ^e	(36)
Control (14)	.98	(109)	1.08	(82)	1.02	(191)
Teacher Exchange + Control (16)	.79	(136)	1.05 ^c	(91)	.90	(227)
Total (34)		(253)		(218)		(471)

a, b, c, ..., t assigned to means to indicate that one mean is significantly different from another with the same superscript ($p < .05$).

The Three Scales

The Pure Sample. Separate analyses of the three scales, Computation (Table 11), Concepts (Table 12), and Application (Table 13), were carried out using the msws from the multivariate analysis. Two analyses (by classroom and by [sex x condition]) were conducted for each scale parallel to those conducted for You and School. The only analyses in which significant differences were obtained were on the Computation Scale. Table 11 presents the means for the Pure Sample, and none of the pretest differences were significant. Thus it is reasonable to rely on the significant posttest differences which indicate that the peer-taught Ss were reliably superior ($x=6.55$) to the Ss in the Teacher Exchange ($x=4.66$) and Specialist conditions ($x=5.31$). However, they were not superior to the control Ss ($x=6.67$). In addition, there was a significant sex difference within the Peer Teaching condition; the females being reliably better ($x=6.94$) in computation than the males ($x=6.18$). Although the other sex differences were not statistically significant, the peer-taught females showed reliably higher scores in computation on the posttest than peer-taught males.

Switched Sample. In the analysis of the total scores on the CTBS, the only significant finding was that the gain scores were significantly greater for those switched into the Peer Teaching condition ($n=27$) ($x=1.33$) than for those switched into the Teacher Exchange condition ($n=15$) ($x=.37$). None of the analyses of the individual scales were significant, possibly due to the fact that the sample size was small and variability large.

Table 11

Mean Scores for the Computation Scale of the Comprehensive Test of Basic Skills
for the Pure Sample, by condition

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>						
		(Interpreted)		(Interpreted)		
Peer Teaching (14)	6.94 ^a	(86)	6.18 ^a	(93)	6.55 ^{bc}	(179)
Specialist (4)	5.69	(31)	5.03	(34)	5.31 ^c	(65)
Peer Teaching + Specialist (18)	6.61	(117)	5.87	(127)	5.93 ^b	(244)
Teacher Exchange (2)	4.62	(27)	4.78	(9)	4.66 ^b	(36)
Control (14)	6.64	(109)	6.71	(82)	6.67	(191)
Teacher Exchange + Control (16)	6.24	(136)	6.52	(91)	5.66	(227)
Total (34)						
<u>PRETEST</u>						
Peer Teaching (14)	5.72	(86)	5.27	(93)	5.49	(179)
Specialist (4)	5.68	(31)	4.86	(34)	5.25	(65)
Peer Teaching + Specialist (18)	5.71	(117)	5.16	(127)	5.42	(244)
Teacher Exchange (2)	4.61	(27)	4.06	(9)	4.47	(36)
Control (14)	5.51	(109)	5.32	(82)	5.44	(191)
Teacher Exchange + Control (16)	5.33	(136)	5.20	(91)	5.28	(227)
Total (34)						
<u>POST - PRETEST</u>						
		(Not Interpreted)		(Not Interpreted)		
Peer Teaching (14)	1.22	(86)	.91	(93)	1.06	(179)
Specialist (4)	.01	(31)	.17	(34)	.08	(65)
Peer Teaching + Specialist (18)	.90	(117)	.71	(127)	.80	(244)
Teacher Exchange (2)	.02	(27)	.72	(9)	.20	(36)
Control (14)	1.13	(109)	1.39	(82)	1.24	(191)
Teacher Exchange + Control (16)	.91	(136)	1.32	(91)	1.08	(227)
Total (34)						

Table 12

Mean Scores for the Concept Scale of the Comprehensive Test of Basic Skills
for the Pure Sample by Condition

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>						
	(Interpreted)		(Interpreted)			
Peer Teaching (14)	6.48	(86)	6.34	(93)	6.41	(179)
Specialist (4)	5.49	(31)	5.06	(34)	5.27	(65)
Peer Teaching + Specialist (18)	6.22	(117)	6.00	(127)	6.11	(244)
Teacher Exchange (2)	4.21	(27)	4.86	(9)	4.37	(36)
Control (14)	6.32	(109)	6.19	(82)	6.26	(191)
Teacher Exchange + Control (16)	5.90	(136)	6.05	(91)	5.96	(227)
Total (34)						
<u>PRETEST</u>						
Peer Teaching (14)	5.62	(86)	5.32	(93)	5.46	(179)
Specialist (4)	5.26	(31)	5.30	(34)	5.28	(65)
Peer Teaching + Specialist (18)	5.52	(117)	5.31	(127)	5.41	(244)
Teacher Exchange (2)	4.11	(27)	4.14	(9)	4.12	(36)
Control (14)	5.32	(109)	5.38	(82)	5.34	(191)
Teacher Exchange + Control (16)	5.08	(136)	5.26	(91)	5.15	(227)
Total (34)						
<u>POST - PRETEST</u>						
	(Not Interpreted)		(Not Interpreted)			
Peer Teaching (14)	.87	(86)	1.03	(93)	.95	(179)
Specialist (4)	.23	(31)	-.23	(34)	-.01	(65)
Peer Teaching + Specialist (18)	.70	(117)	.69	(127)	.69	(244)
Teacher Exchange (2)	.11	(27)	.71	(9)	.26	(36)
Control (14)	1.00	(109)	.81	(82)	.93	(191)
Teacher Exchange + Control (16)	.82	(136)	.80	(91)	.81	(227)
Total (34)						

Table 13

Mean Scores for the Applications Scale of the Comprehensive Test of Basic Skills
for the Pure Sample, by Condition

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>						
	(Interpreted)		(Interpreted)			
Peer Teaching (14)	6.09	(86)	5.62	(93)	5.84	(179)
Specialist (4)	4.68	(31)	4.48	(34)	4.54	(65)
Peer Teaching + Specialist (18)	5.71	(117)	5.31	(127)	5.40	(244)
Teacher Exchange (2)	3.65	(27)	4.13	(9)	3.77	(36)
Control (14)	5.67	(109)	5.80	(82)	5.70	(191)
Teacher Exchange + Control (16)	5.26	(136)	5.63	(91)	5.40	(227)
Total (34)						
<u>PRETEST</u>						
Peer Teaching (14)	5.04	(86)	4.82	(93)	4.92	(179)
Specialist (4)	4.73	(31)	5.21	(34)	4.98	(65)
Peer Teaching + Specialist (18)	4.96	(117)	4.92	(127)	4.93	(244)
Teacher Exchange (2)	4.12	(27)	3.96	(9)	4.08	(36)
Control (14)	4.86	(109)	4.83	(82)	4.84	(191)
Teacher Exchange + Control (16)	4.71	(136)	4.74	(91)	4.72	(277)
Total (34)						
<u>POST - PRETEST</u>						
	(Not Interpreted)		(Not Interpreted)			
Peer Teaching (14)	1.05	(86)	.81	(93)	.93	(179)
Specialist (4)	-.05	(31)	-.72	(34)	-.40	(65)
Peer Teaching + Specialist (18)	.76	(117)	.40	(127)	.57	(244)
Teacher Exchange (2)	-.48	(27)	.18	(9)	-.32	(36)
Control (14)	.81	(109)	.97	(82)	.88	(191)
Teacher Exchange + Control (16)	.55	(136)	.88	(91)	.68	(227)
Total (34)						

THE RAVEN

Method

The Standard Progressive Matrices was administered in accordance with the standardized instructions. This test was standardized by J.C. Raven and published by the Psychological Corporation, 1958. Although it is believed to be a non-verbal measure of general ability, we included it as a measure of ability to reason both inductively and deductively, using non-verbal materials. As such, it should tap an ability which should be developed by the learning of mathematical concepts.

Examples of the test follow. The directions are to indicate which of the six choices at the bottom belongs in the blank space at the top.

Standard Progressive Matrices

(Examples)

Directions: Indicate which of the six choices at the bottom belongs in the blank space at the top.

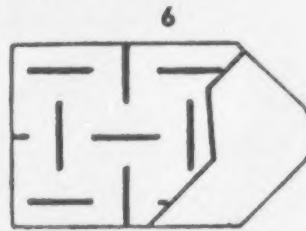
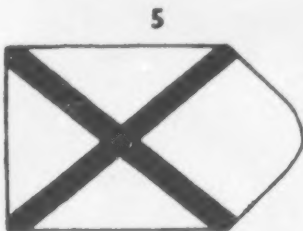
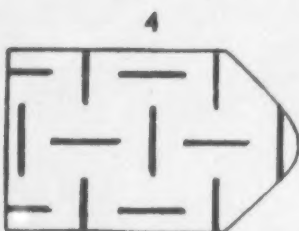
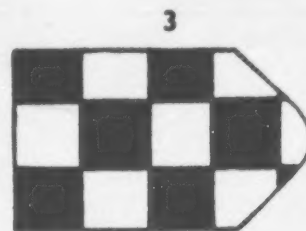
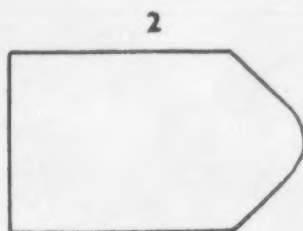
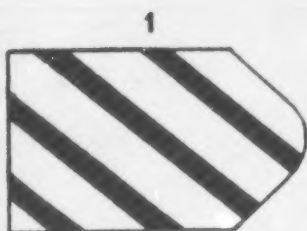
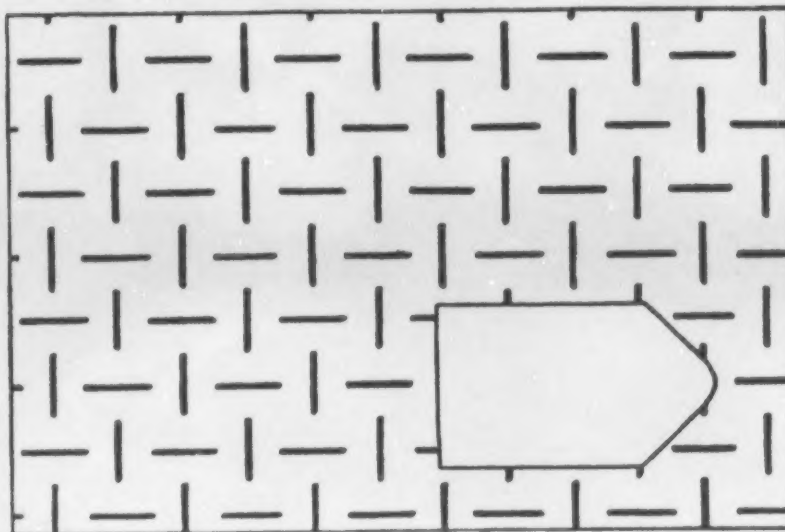
NAME _____

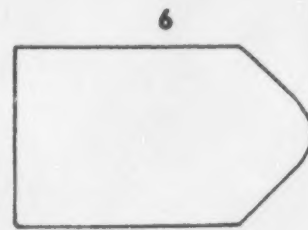
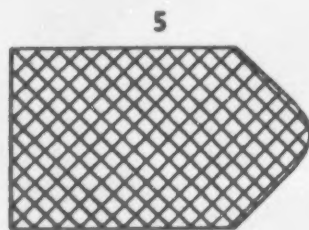
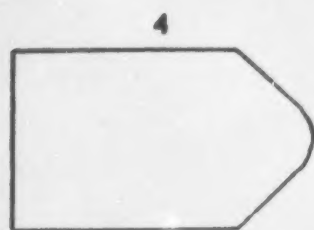
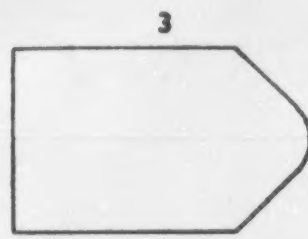
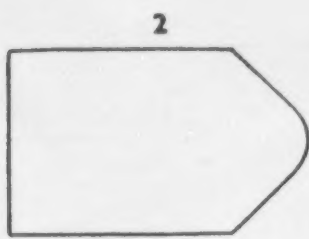
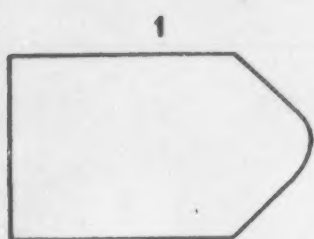
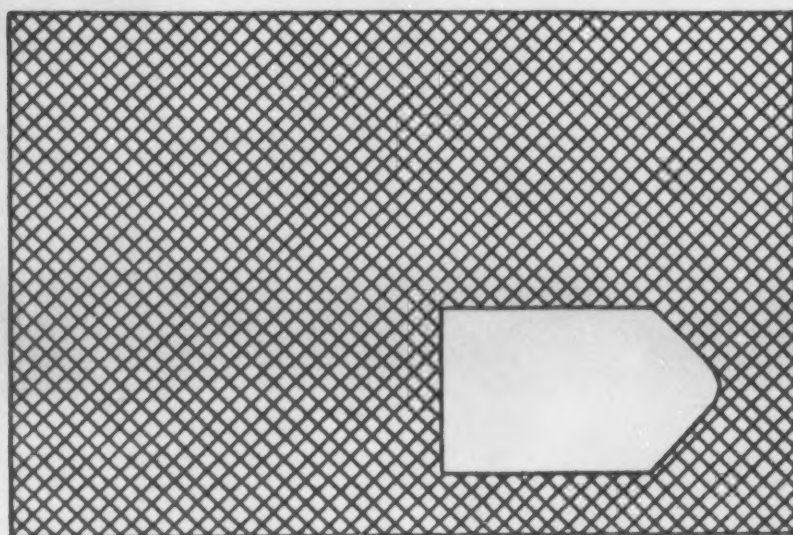
DATE _____

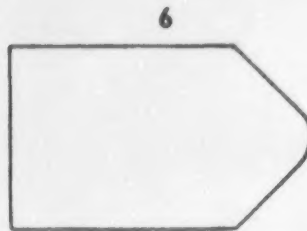
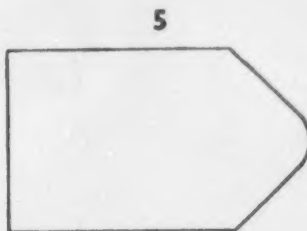
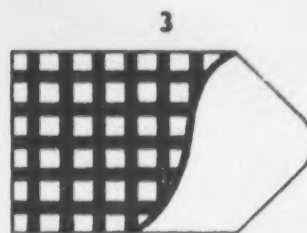
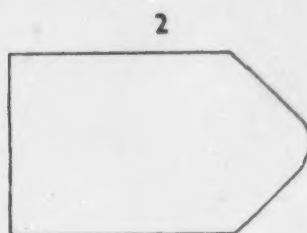
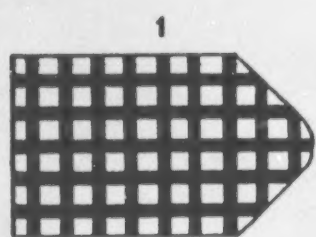
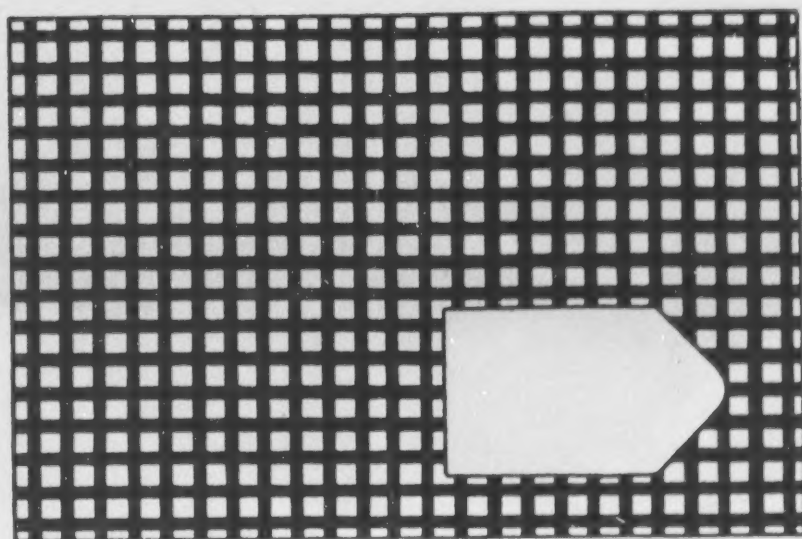
TEACHER _____

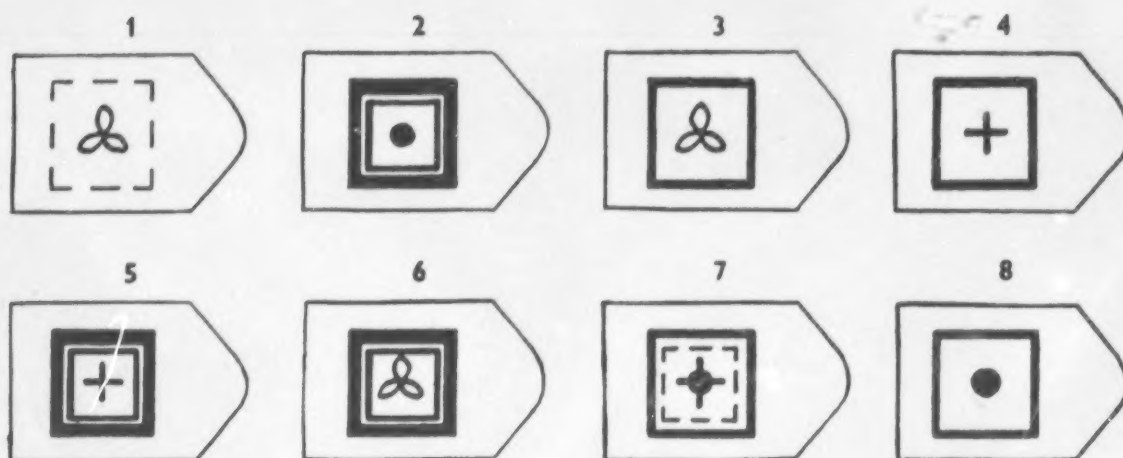
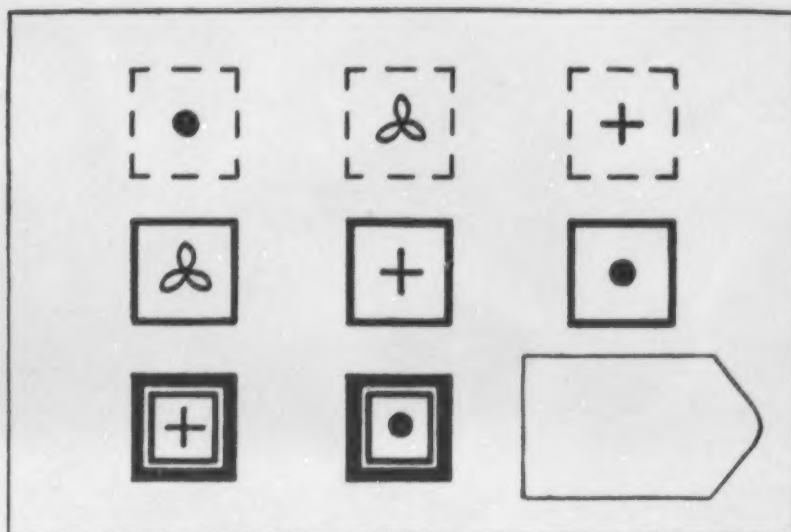
SCHOOL _____

Patterns part two









Results: Raven Progressive Matrices

The number of Ss in the Pure, Switched, Makeup Pure, and Makeup Switched Samples were 439, 57, 51, and 12, respectively. The mean scores by condition for the Pure Sample are shown in Table 14. Only one measure, total correct, was obtained, and therefore no multivariate analyses were employed. Two analyses were carried out for the Pure Sample--one involving the 34 classrooms as the unit and disregarding the sex of the Ss, and the other involving the eight [Sex by Condition] groups. The Posttest, Pretest, and Difference scores were each analysed in these ways. The Switch Sample was only processed with the [Sex by Condition] analysis. The Pure Makeup Sample was processed with the [Sex by Condition] analysis which excluded the Teacher Exchange condition, since there were no Ss in this condition within this sample. The Makeup Switched Sample was processed as a two-group analysis since there were so few Ss (12) in the sample.

Pure Sample

The analyses of the pretest on the Raven did not yield significant differences between groups, and therefore we relied on the posttest analyses. As shown in Table 14, this measure revealed that for the total group, the peer-taught Ss showed significantly higher performance (15.24) than the Controls (14.24). Similarly, for the analysis by Sex, the females who were peer taught performed significantly better on the posttest (15.27) than the females in the combined Teacher Exchange and Control conditions (14.40). However, the trend of the means showed these peer-taught groups to have had higher means than their respective controls on the pretest; yet, inspection

Table 14

Mean Scores (total correct) for the Raven Progressive Matrices
for the Pure Sample, by Condition and Sex

CONDITION (# CLASSES)	Female	(n)	Males	(n)	Total	(n)
<u>POSTTEST</u>						
	(Interpreted)			(Interpreted)		
Peer Teaching (14)	15.27 ^a	(92)	15.22	(80)	15.24 ^q	(172)
Specialist (4)	14.37	(30)	14.67	(30)	14.53	(60)
Peer Teaching + Specialist (18)	15.05	(122)	15.07	(110)	15.06	(232)
Teacher Exchange (2)	13.77	(26)	15.25	(8)	14.50	(34)
Control (14)	14.56	(105)	13.96	(68)	14.24 ^q	(173)
Teacher Exchange + Control (16)	14.40 ^a	(131)	14.10	(76)	14.29	(207)
Total		(253)		(186)		(439)
<u>PRETEST</u>						
Peer Teaching (14)	16.72	(92)	16.46	(80)	16.48	(172)
Specialist (4)	16.60	(30)	16.33	(30)	16.46	(60)
Peer Teaching + Specialist (18)	16.69	(122)	16.43	(110)	16.47	(232)
Teacher Exchange (2)	14.77	(26)	18.75	(8)	16.61	(34)
Control (14)	16.04	(105)	15.38	(68)	15.72	(173)
Teacher Exchange + Control (16)	15.79	(131)	15.73	(76)	15.86	(207)
Total		(253)		(186)		(439)
<u>POST - PRETEST</u>						
	(Not Interpreted)			(Not Interpreted)		
Peer Teaching (14)	-1.45	(92)	-1.25	(80)	-1.25	(172)
Specialist (4)	-2.23	(30)	-1.67	(30)	-1.93	(60)
Peer Teaching + Specialist (18)	-1.63	(122)	-1.36	(110)	-1.43	(232)
Teacher Exchange (2)	-1.00	(26)	-3.50	(8)	-2.12	(34)
Control (14)	-1.47	(105)	-1.43	(68)	-1.47	(173)
Teacher Exchange + Control (16)	-1.38	(131)	-1.65	(76)	-1.58	(207)
Total		(253)		(186)		(439)

a, b, c, ...p = significant $p < .05$; q, r, ...z = significant at $p < .05$

of the difference scores for the total group indicates that the drop from pretest to posttest was smaller for the peer-taught groups than for their respective control comparison groups. The fact that all groups showed a decline in the Raven over the course of the year is not hard to explain. We used two forms of the Raven, one for the pretest and one for the posttest. Although "odd-even" items were selected for the two forms, it is likely that they differed in difficulty. Perhaps also, Ss were not as motivated on the re-test as they were on the original testing. It is hard to believe that the ability to form nonverbal reasoning actually would decline in any condition.

Switched Sample

As for the Pure Sample, almost all the difference scores for the Switched Sample were negative. However, none of the between-group differences were significant. It was, however, true that the decline in the Raven scores (-1.81) in the peer-taught group (n=21) tended to be smaller overall than the decline (-2.44) in the controls (n=25).

Makeups

None of the hypothesized differences in the Makeup Samples were statistically significant; but again, the consistent decline in all scores from the pre- to the posttest were present in both makeup samples.

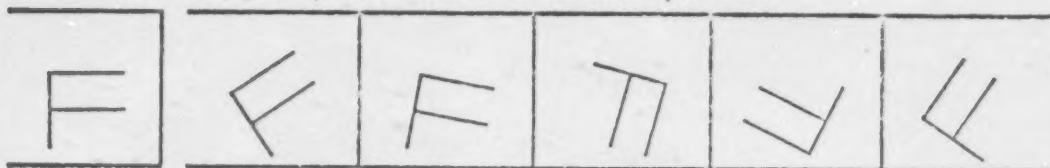
PRIMARY MENTAL ABILITIES

Method

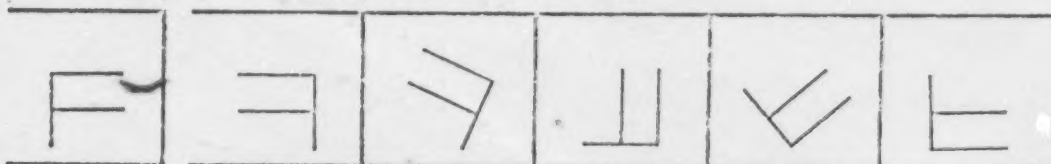
The PMA subtest that was employed was the Spatial Relations Subtest of the Primary Mental Abilities Test, published by Science Research Associates, Inc., 1962. It was administered to groups in accordance with the standardized procedure. The Spatial Relations Test may be assumed to measure the orientation factor within spatial ability and emphasizes the ability to recognize objects rotated in space. Although the mathematics being taught in the seventh grade was not geometry, it was believed that the special mathematics curriculum should stimulate use of spatial abilities and perhaps contribute to the development of spatial ability. The test which was employed follows.

PRACTICE EXERCISES

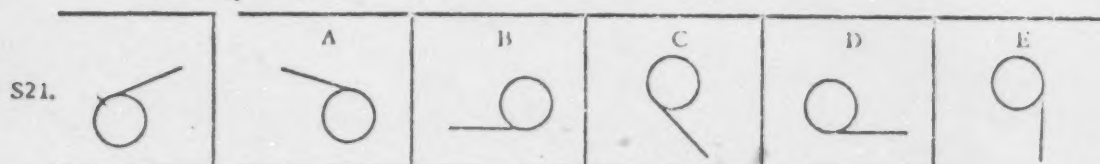
This is a test to see how well you can recognize figures and forms. The first figure in the row looks like an *F*. All of the other figures in the row are like the first one, but they have been rotated to different positions.



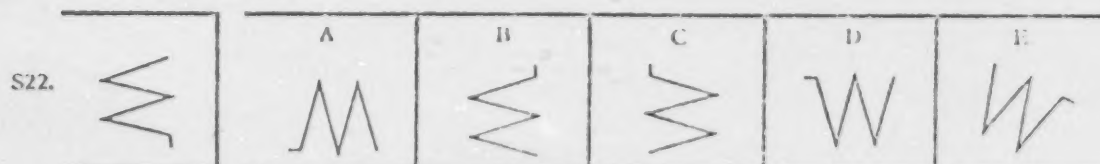
Now look at the next row of figures. The first figure is like the letter *F*. However, none of the other figures would look like an *F* even if they were rotated to upright positions. They are all drawn backward.



In Spatial Relations sample problem S21 some of the figures in the row are like the first figure. Some are drawn backward. Find the figures that are the same as the first one in the row. As you take this test remember that there may be more than one correct answer and that some of the correct figures may be rotated to various positions.



In sample problem S21 two of the figures are the same as the first figure in the row. These are the figures below the letters *B* and *E*. Now find the Spatial Relations sample answer spaces on your answer sheet. Make a heavy mark in spaces *B* and *E* in answer row S21 on your answer sheet in the Spatial Relations Samples section. Look at the row of figures in sample problem S22 and make a heavy mark on your answer sheet in the space for each letter that represents a correct answer.



You should have blackened spaces *A*, *C*, and *E* in sample answer row S22 on your answer sheet, because those letters represent the figures that are the same as the first figure in the row, even though these figures are rotated to different positions.

In sample problems S23 and S24 blacken the spaces in answer rows S23 and S24 representing the figures that are the same as the first figure in that row.

S23.		A 	B 	C 	D 	E
S24.		A 	B 	C 	D 	E

In sample problem S23 you should have blackened space B. In sample problem S24 you should have blackened spaces B, D, and E.

Remember that in each row there may be more than one figure like the first one.

Be sure you understand how to work this kind of problem.

When you are given the signal to begin, you are to work more problems like those above. Work quickly, but try not to make mistakes. Do not spend too much time on a problem that gives you trouble, but mark what you think is the best answer and go on to the next problem. If you finish before time is called, you may go back and check your answers *on this test only*.

If you wish to change an answer, be sure to erase your first mark completely before making another mark. You are not to make any marks in the test booklet.

There are three pages of Spatial Relations problems.

Directions: Circle the letters of the correct answers.
There may be more than one right answer.

1.		A 	B 	C 	D 	E
2.		A 	B 	C 	D 	E
3.		A 	B 	C 	D 	E
4.		A 	B 	C 	D 	E
5.		A 	B 	C 	D 	E
6.		A 	B 	C 	D 	E
7.		A 	B 	C 	D 	E
8.		A 	B 	C 	D 	E
9.		A 	B 	C 	D 	E
10.		A 	B 	C 	D 	E

GO ON TO NEXT PAGE

11.		A 	B 	C 	D 	E
12.		A 	B 	C 	D 	E
13.		A 	B 	C 	D 	E
14.		A 	B 	C 	D 	E
15.		A 	B 	C 	D 	E
16.		A 	B 	C 	D 	E
17.		A 	B 	C 	D 	E
18.		A 	B 	C 	D 	E
19.		A 	B 	C 	D 	E
20.		A 	B 	C 	D 	E

GO ON TO NEXT PAGE

21.		A	B	C	D	E
22.		A	B	C	D	E
23.		A	B	C	D	E
24.		A	B	C	D	E
25.		A	B	C	D	E
26.		A	B	C	D	E
27.		A	B	C	D	E
28.		A	B	C	D	E
29.		A	B	C	D	E
30.		A	B	C	D	E

Results: Primary Mental Abilities

The number of Ss in the Pure, Switched, Makeup Pure and Makeup Switched samples were 436, 56, 55, and 15, respectively. The means of Ss by condition for the Pure Sample is shown in Table 15. The scores represent the number of correct items minus the number of incorrect items. Except for the Switched Sample, the gains in score over the course of the school year were large and positive.

The Pure Sample

The only significant comparison in the pretest for the Pure Sample (Table 15) was that the males in the control group had significantly higher scores (21.75) on the Primary Mental Abilities Scale than the females (15.96). Thus, it is reasonable to consider the posttest analysis for the evaluation of between condition effects and the post-pretest scores for evaluation of the sex differences. The sex differences obtained on the pretest were reversed on the posttest. The females in the control group made very large gains during the course of the year ($x=9.13$) compared with the males ($x=3.74$). Thus, although the control females had lower scores than the males on the pretest, they made significantly greater gains than the males in the control condition. The females in the Teacher Exchange condition ($x=5.07$) also made significantly greater gains than the males ($+ .75$) and were also lower at the outset, though not reliably lower.

The most striking effect of peer teaching is evident in the overall analysis of the posttest data. The peer-taught Ss excelled ($p < .05$) over the Teacher Exchange Ss and the Controls on the posttest. The means were

Table 15

Mean Scores (Right-Wrong) for the Primary Mental Abilities Scale
for the Pure Sample, by Condition and Sex

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>		(Not Interpreted)		(Interpreted)		
Peer Teaching (14)	28.80	(91)	31.12	(81)	30.02 ^{r q}	(172)
Specialist (4)	24.07	(30)	33.90	(30)	29.05	(60)
Peer Teaching + Specialist (18)	27.62	(121)	31.87	(111)	29.77 ^k	(232)
Teacher Exchange (2)	21.69	(26)	26.88	(8)	22.23 ^q	(34)
Control (14)	25.08	(104)	25.50	(66)	25.23 ^r	(170)
Teacher Exchange + Control (16)	24.41	(130)	25.65	(74)	24.73 ^k	(204)
Total		(251)		(185)		(436)
<u>PRETEST</u>						
Peer Teaching (14)	20.03	(91)	22.72	(81)	21.56	(172)
Specialist (4)	16.03	(30)	24.30	(30)	20.08	(60)
Peer Teaching + Specialist (18)	19.04	(121)	23.15	(111)	21.18	(232)
Teacher Exchange (2)	16.62	(26)	26.13	(8)	18.86	(34)
Control (14)	15.96 ^q	(104)	21.75 ^q	(66)	17.97	(170)
Teacher Exchange + Control (16)	16.09	(130)	22.23	(74)	18.12	(204)
Total		(251)		(185)		(436)
<u>POST - PRETEST</u>		(Interpreted)		(Not Interpreted)		
Peer Teaching (14)	8.77	(91)	8.41 ^c	(81)	8.46	(172)
Specialist (4)	8.03	(30)	9.60	(30)	8.96	(60)
Peer Teaching + Specialist (18)	8.59	(121)	8.73	(111)	8.60	(232)
Teacher Exchange (2)	5.07 ^a	(26)	.75 ^a	(8)	3.38	(34)
Control (14)	9.13 ^b	(104)	3.74 ^b	(66)	7.26	(170)
Teacher Exchange + Control (16)	8.32	(130)	3.42 ^c	(74)	6.61	(204)
Total		(251)		(185)		(436)

a,b,c,...p = significant $p < .05$; q,r,...z = significant at $p < .05$

30.02, 22.23, and 25.23, respectively. Ss in the Peer Teaching and Specialist condition combined also excelled ($p < .05$) over the Teacher Exchange and Controls combined, with means of 29.77 and 24.73, respectively. The trends of the means within the male and female groups were consistent with the overall findings, but the treatments had a significant effect only on the males. Specifically, the analysis of the difference scores indicated that peer-taught males showed significantly ($p < .05$) higher gains (8.41) than the Teacher Exchange and Control males (3.42) while the gains for the comparable females tended in the reverse direction and were not significant.

The Switched Sample

Although none of the PMA analyses on the Switched Sample yielded significant results, the overall means on the posttest were consistent with the Pure Sample in that the means for the Peer Teaching ($n=20$) ($\bar{x}=28.85$) and Specialist conditions ($n=10$) ($\bar{x}=29.80$) were higher than the means for the control condition ($n=26$) ($\bar{x}=24.65$). The means for the difference scores were also totally consistent with the significant effects reported for the Pure Sample.

The Makeup Samples

No significant differences were obtained for the PMA on any of the analyses conducted on the Makeup Samples. The Pure Makeup Sample means were not particularly consistent with the reliable effects reported above. However, the pretest differences were quite large, e.g. the peer teaching group ($n=28$) had a mean of 20.51 while the controls ($n=22$) had a mean of 15.05. The posttest means were 26.47 for the peer-taught group and 25.50 for the controls. There were only 5 cases in the Specialist condition.

The trends of the Switched Makeup Sample suggested that the peer-taught Ss (n=4) showed smaller losses over the year ($x=-.75$) than the other Ss combined (n=11) ($x=-1.09$). However, the number of cases was extremely small for this analysis and the scores on the pretest made by the peer-taught Ss were very high.

THE CATTELL

Method

The subtest employed for the evaluation tests the ability to form concepts from nonverbal information. This subtest of the Cattell, published by the Institute for Personality and Ability Testing, 1949, 1957, 1961, is provided below.

Name _____

Date _____

School _____

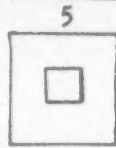
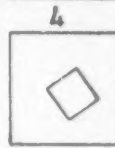
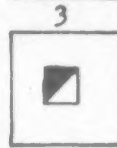
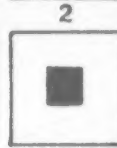
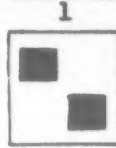
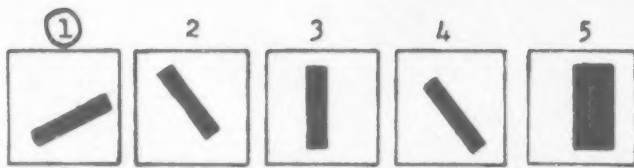
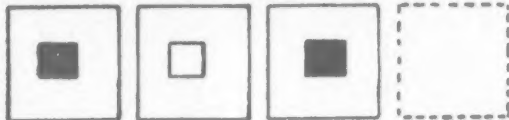
Teacher _____

PATTERNS

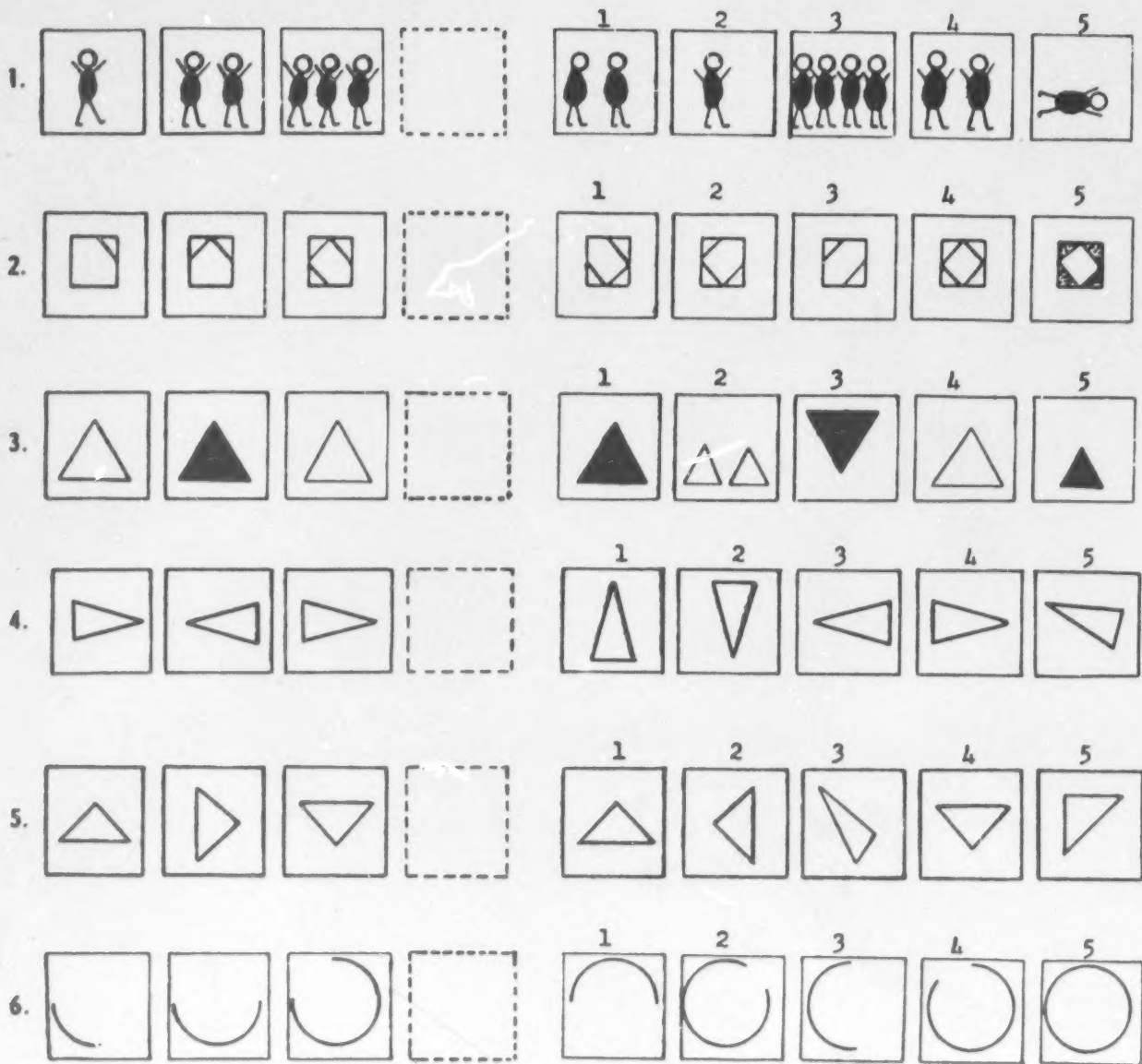
Part One

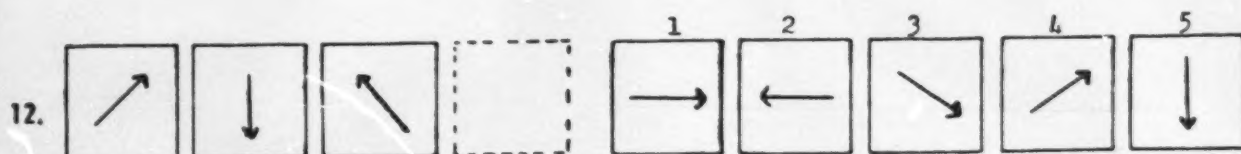
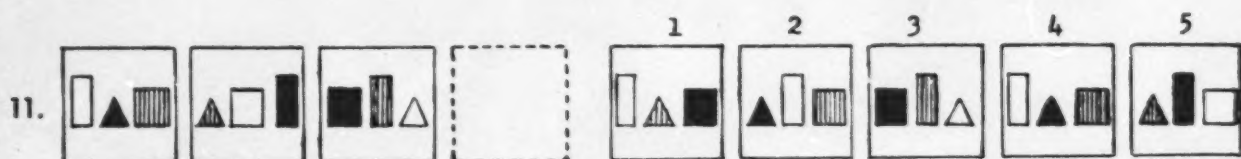
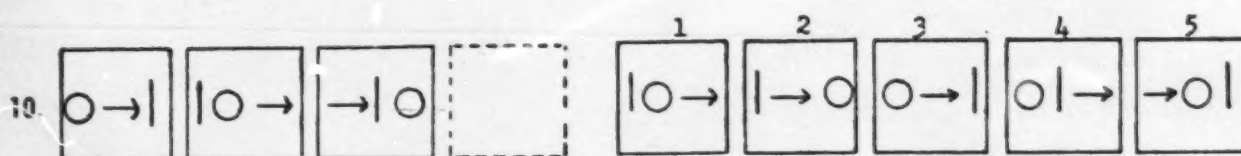
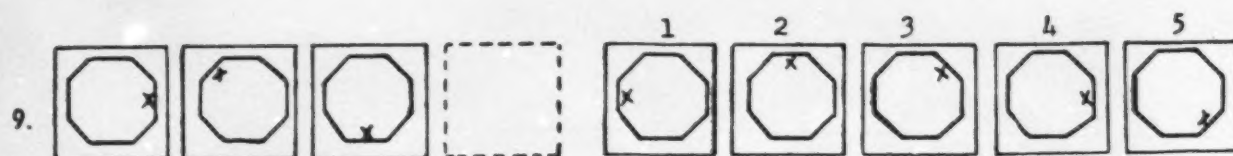
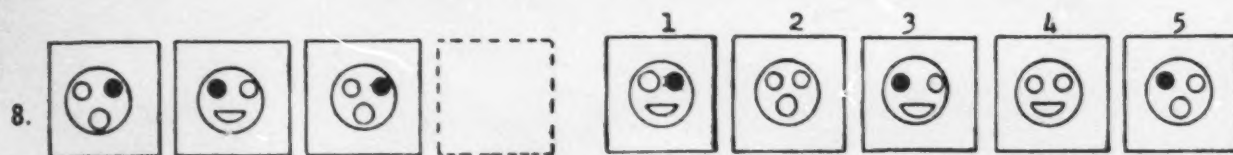
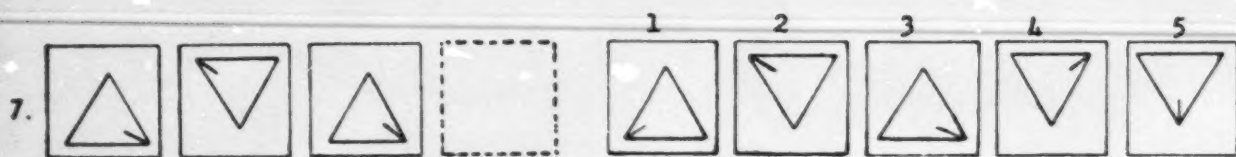
Directions: Circle the number of the answer that completes the pattern.

EXAMPLES



Wait





Results: The Cattell

The number of Ss in the Pure, Switched, Makeup Pure, and Makeup Switched Samples were 442, 65, 79, and 13, respectively. The means for the Pure Samples are shown in Table 16. The test reflects the ability to form concepts based on spatially presented information.

The Pure Sample

Significant differences between conditions were found for males and females on the pretest. Therefore, the change schores will be employed to evaluate the Sex and Condition effects. As shown in Table 40, the pretest performance of the females in the Peer Teaching condition (6.75) was significantly lower than the performance of the females in the combined control conditions (7.54) while the performance of the males in the Peer Teaching condition (7.60) was significantly higher than the males in the combined control conditions (6.59). It was also the case that for the males, pretest performance was higher in the Peer Teaching and Specialist conditions combined (7.38) than in the combined control conditions (6.59); and the pretest scores made by the females in the Control condition (7.71) were significantly higher than the scores made by the males in this condition (6.64). Since the overall scores did not differ in the pretest, posttest scores are used to evaluate the overall effects. However, none of the overall differences were significant.

The difference scores reveal that the females in the Peer Teaching condition showed a greater improvement in concept formation over the year (1.59) than the controls from which they differed reliably and who showed a decline (-1.07). By contrast, the males in the Peer Teaching condition actually showed

Table 16

Mean Scores for the Cattell for the Pure Sample, by Condition

CONDITION (# CLASSES)	Female	(n)	Male	(n)	Total	(n)
<u>POSTTEST</u>	(Not Interpreted)			(Interpreted)		
Peer Teaching (14)	8.34 ^{ac}	(85)	6.55 ^{abf}	(103)	7.36	(188)
Specialist (4)	7.00	(28)	7.78	(27)	7.38	(55)
Peer Teaching + Specialist (18)	8.01 ^d	(113)	6.81 ^e	(130)	7.37	(243)
Teacher Exchange (2)	7.36	(25)	9.00 ^b	(6)	7.68	(31)
Control (14)	6.64	(101)	8.03	(67)	7.19	(168)
Teacher Exchange + Control (16)	6.78 ^{cd}	(126)	8.11 ^{ef}	(73)	7.27	(199)
Total (34)		(239)		(203)		(442)
<u>PRETEST</u>						
Peer Teaching (14)	6.75 ^g	(85)	7.60 ^h	(103)	7.22	(188)
Specialist (4)	7.89	(28)	6.56	(27)	7.23	(55)
Peer Teaching + Specialist (18)	7.03	(113)	7.38 ^j	(130)	7.21	(243)
Teacher Exchange (2)	6.88	(25)	6.00	(6)	6.71	(31)
Control (14)	7.71 ⁱ	(101)	6.64 ⁱ	(67)	7.28	(168)
Teacher Exchange + Control (16)	7.54 ^g	(126)	6.59 ^{hj}	(73)	7.19	(199)
Total (34)		(239)		(203)		(442)
<u>POST - PRETEST</u>	(Interpreted)			(Not Interpreted)		
Peer Teaching (14)	1.59 ^{qt}	(85)	-1.05 st	(103)	.14	(188)
Specialist (4)	-.85 ^u	(28)	1.22 ^u	(27)	.15	(55)
Peer Teaching + Specialist (18)	.98 ^r	(113)	-.58 ^w	(130)	.15	(243)
Teacher Exchange (2)	.48	(25)	3.00	(6)	.97	(31)
Control (14)	-1.07 ^v	(101)	1.39 ^v	(67)	-.09	(168)
Teacher Exchange + Control (16)	-.76 ^{qr}	(126)	1.52 ^{sw}	(73)	.08	(199)
Total (34)		(239)		(203)		(442)

a,b,c,...p = significant $p < .05$; q, r, ..., z = significant at $p < .05$

a decline over the year (-1.05) compared with the males in the combined control conditions who showed a gain (1.52). This difference between conditions was also significant for the males. Clearly the effect of the Peer Teaching condition was opposite for the two sexes, i.e., Peer Teaching facilitated concept formation in females and depressed it in males.

The sex differences on the analysis of the difference scores indicate that the females in the Peer Teaching condition showed a significantly greater gain than the males, who showed a loss over the year. However, in contrast to the results for peer teaching, the males in the Specialist condition showed a gain over the year (1.22) as compared with the females, who showed a decrement (-.89). No other sex differences were significant, although the trend of the means suggests that the results found for the control conditions were in the same direction as those found for the Specialist conditions, i.e., boys showing greater improvement than girls, while the deviant effect was in the Peer Teaching condition, i.e., girls showing greater improvement than boys.

The Switched Sample

None of the results for the Switched Sample were statistically reliable. The overall gain for the peer-taught group ($n=25$) was +1.40 and for the controls ($n=28$), +1.36.

The Makeup Samples

None of the differences in the analyses of the Makeup Samples were statistically significant. For the Pure Makeup Sample, both males and females in the Peer Teaching condition showed a greater improvement during the year than the controls. The posttest minus pretest means for the total group were +1.93 for the peer-taught Ss ($n=31$) and -1.14 for the controls ($n=38$). The Makeup Switched Sample ($n=13$) also showed the peer-taught Ss ($n=3$) to have a greater gain (1.67) than the others (-1.30) ($n=10$).

SUPPLEMENTARY RESULTS: PART I

The preceding results consider peer teaching as if it were a unitary condition, when in fact there were five different types of peer teaching:

- a. One female peer teacher (5 classes)
- b. One male peer teacher (2 classes)
- c. Two female peer teachers (1 class)
- d. Two male peer teachers (2 classes)
- e. Two peer teachers, one male and one female (4 classes)

Sex differences obtained in analyses already reported suggested the possibility that the effect of peer teaching might well depend on both the sex of the peer teacher and the sex of the student. In addition, it is of preliminary interest to consider the possibility of a difference in the effect of peer teaching as a function of whether one or two peer teachers were employed in the classroom. For example, if it is found beneficial to use two peer teachers rather than one, the possibility of benefit to more peer teachers is provided, and the use of teacher pairs might be further investigated in a future study.

In order to evaluate the possible benefits of type of peer teaching, ten experimental groups were compared from the Pure Sample for the three most promising measures: the PMA, the CTBS total score, and the Cattell. The ten groups were:

1. Females who had one female peer teacher
2. Females who had one male peer teacher
3. Females who had two female peer teachers
4. Females who had two male peer teachers
5. Females who had two peer teachers, one male and one female

6. Males who had one female peer teacher
7. Males who had one male peer teacher
8. Males who had two female peer teachers
9. Males who had two male peer teachers
10. Males who had two peer teachers, one male and one female.

Using the same method employed earlier, comparisons between the ten groups were made using Dunn Contrasts. The particular family of comparisons for which a priori significance tests were performed were:

- a) 2 + 4 (Females who had either one or two male peer teachers) versus
1 + 3 (Females who either had one or two female peer teachers)
- b) 6 + 8 (Males who had either one or two male peer teachers) versus
7 + 9 (Males who had either one or two female peer teachers)
- c) 1 + 2 (Females who had one peer teacher of either sex) versus
3 + 4 + 5 (Females who had two peer teachers, regardless of sex)
- d) 6 + 7 (Males who had one peer teacher of either sex) versus
8 + 9 + 10 (Males who had two peer teachers, regardless of sex).

The same family of contrasts were performed for the CTBS (Table 17), the PMA (Table 18), and the Cattell (Table 19). None of the contrasts were significant for the PMA. For the CTBS, contrast (d) yielded a significant difference; specifically, males with two peer teachers showed a significantly larger gain on the CTBS total score (+1.27) than the males with only one peer teacher (+.45). For the Cattell, contrast (b) was significant, indicating that males who had one or two male teachers showed less gain on the Cattell (.64) than males who had one or two female peer teachers (1.74).

Table 17

Means for Males and Females within the Peer Teaching Conditions
as a Function of Number and Sex of Peer Teacher:
CTBS Total Score

Group	<u>N</u>	POST	PRE	DIFF
1 Females with one female P.T.	32	6.23	5.35	.88
2 Females with one male P.T.	11	6.13	5.47	.65
3 Females with two female P.T.s	10	6.09	5.33	.76
4 Females with two male P.T.s	11	7.79	6.57	1.22
5 Females with two P.T.s, diff. sexes	22	6.89	5.34	1.55
6 Males with one female P.T.	28	5.42	4.87	.55
7 Males with one male P.T.	14	5.59	5.33	.26
8 Males with two female P.T.s	5	5.28	4.90	.38
9 Males with two male P.T.s	10	6.32	5.66	.66
10 Males with two P.T.s, diff. sexes	36	6.88	5.32	1.56
2 + 4		6.96	6.02	.94
1 + 3		6.20	5.34	.85
7 + 9		5.89	5.47	.43
6 + 8		5.40	4.87	.53
1 + 2		6.20	5.38	.82
3 + 4 + 5		6.94	5.65	1.28
6 + 7		5.48 ^a	5.03	.45 ^b
8 + 9 + 10		6.61 ^a	5.34	1.27 ^b

a,b = significant p .05

Table 18

Means for Males and Females within the Peer Teaching Conditions
as a Function of Number and Sex of Peer Teacher:

PMA				
Group	<u>N</u>	POST	PRE	DIFF
1 Females with one female P.T.	36	30.92	24.69	6.22
2 Females with one male P.T.	14	27.0	15.28	11.71
3 Females with two female P.T.s	9	30.11	17.67	12.44
4 Females with two male P.T.s	10	36.50	23.20	13.30
5 Females with two P.T.s, diff. sexes	22	32.45	14.95	7.50
6 Males with one female P.T.	24	27.42	18.17	9.25
7 Males with one male P.T.	17	30.41	22.41	8.0
8 Males with two female P.T.s	3	28.0	10.33	17.67
9 Males with two male P.T.s	8	29.0	24.12	4.88
10 Males with two P.T.s, diff. sexes	29	36.28	29.14	7.14
2 + 4		30.96	18.58	12.37
1 + 3		30.76	23.29	7.46
7 + 9		29.96	22.96	7.0
6 + 8		27.48	17.30	10.18
1 + 2		29.82	22.05	7.76
3 + 4 + 5		27.56	17.56	10.0
6 + 7		28.66	19.93	8.73
8 + 9 + 10		34.20	26.73	7.48

Table 19

Means for Males and Females within the Peer Teaching Conditions
as a Function of Number and Sex of Peer Teacher:
Cattell

Group	N	POST	PRE	DIFF
1 Females with one female P.T.	33	8.73	6.91	1.82
2 Females with one male P.T.	13	7.92	6.69	1.23
3 Females with two female P.T.s	11	7.91	6.82	1.09
4 Females with two male P.T.s	10	9.20	7.60	1.60
5 Females with two P.T.s, diff. sexes	18	7.72	6.00	1.72
6 Males with one female P.T.	29	8.07	6.31	1.76
7 Males with one male P.T.	21	6.86	6.19	.67
8 Males with two female P.T.s	5	9.20	7.60	1.60
9 Males with two male P.T.s	12	7.25	6.67	.58
10 Males with two P.T.s, diff. sexes	36	7.78	6.53	1.25
2 + 4		8.47	7.09	1.39
1 + 3		8.53	6.89	1.64
7 + 9		7.00	6.36	.64 ^a
6 + 8		8.02	6.50	1.74 ^a
1 + 2		8.50	6.84	1.65
3 + 4 + 5		8.15	6.64	1.51
6 + 7		7.56	6.26	1.30
8 + 9 + 10		7.79	7.06	1.13

SUMMARY OF RESULTS: PART I

The major results reported in this section exclude consideration of pretest results and include a) all significant results on posttest or b) all significant difference-scores when the corresponding pretest results were significant. The summary of results is restricted to the Pure Sample and is divided into three types of results: those that refer to observed differences between conditions for the specified sample with the two sexes combined; those that refer to the observed differences between conditions for the males and females considered separately; those that refer to observed differences between males and females within conditions. The summaries are shown in Tables 20, 21, and 22, respectively.

The tests represented in the set for which significant differences were found for the combined sample (Table 20) were three cognitive tests: CTBS, PMA, and Raven. All eight of the significant differences showed the Peer Teaching condition alone or in combination with the Specialist condition to have produced higher scores than the comparison condition. Since the Pure Sample was used for the particular tests of significance, we ascribe considerable stability to the effect. Although it might be said that eight differences could have been significant on the basis of chance alone, the probability that all eight significant differences would be in the same direction and favoring the one-tailed hypothesis tested in this study is low. Thus, the overall result for male and female Ss combined is that peer teaching significantly improved the students' scores on the cognitive measures, relative to other types of teaching conditions which varied depending on the measure examined.

Although no reliable results were obtained for the Cattell, the fourth cognitive test, examining the overall means supports the hypothesis that peer teaching produced greater improvement than the other teaching conditions. Positive attitudes were not reliably affected by the Peer Teaching condition in the Pure Sample.

The effects of Peer Teaching on male Ss, shown in Table 21, were somewhat negative, with the males showing greater gains in the combined control conditions than in the Peer Teaching or Peer Teaching plus Specialist condition, in three out of four reliable results. For the female Ss, however, the hypothesis was supported in all three of the reliable effects. Table 21 shows that the peer-taught females performed better on the posttest, or showed a larger gain on the significant effects on the Raven and the Cattell, than the controls or combined controls. The effects for males on the Cattell was opposite to those found for females. Thus, although the overall effects of peer teaching were favorable, the effect was not consistent for the male Ss.

The six sex differences obtained in the study are shown in Table 22. The females show more positive changes than the males in four of the six significant differences, and both of the effects favoring the males were found on the Cattell and not found within the Peer Teaching condition. The two effects within the Peer Teaching condition favored the females and were on the CTBS and the Cattell. Also, it may be important to note that except for the CTBS effect on the posttest, all the sex differences referred to the difference scores.

The supplementary analyses of the Ss within the Peer Teaching condition show that the effect of peer teaching on the males depended on the sex of

1

the peer teacher and/or the number of peer teachers they had. Specifically, on the CTBS, males with two peer teachers showed a reliably larger gain than males with only one peer teacher, and on the Cattell, males with either one or two female peer teachers showed a significantly larger gain than males who had only male peer teachers.

Table 20

Part I. Summary of Major Results [The Pure Sample]
 Showing all Interpreted Significant Effects between Conditions
 for Males and Females Combined

AN. ¹	Peer Teacher	Spec.	Peer Teacher + Spec.	Teacher Exchange	Control	Teach. Exch. + Control
<u>CTBS</u>						
Total Score -						
Diff	+ .97					
Diff	+ .97	.00		+ .19		
Computation -						
Post	6.55	5.31				
Post	6.55			4.66		
<u>PMA</u>						
Post	30.02			22.23		
Post	30.02				25.23	
Post		29.77				24.73
<u>Raven</u>						
Post	15.24				14.24	

¹
 AN: Analysis refers to Difference score (DIFF) or Posttest score (POST).

Table 21

Part I. Summary of Major Results [The Pure Sample],
 Showing all Interpreted Significant Effects between Conditions
 for Male and Female Ss considered separately

<u>MALES</u>					
	Peer Teacher	Spec.	Peer Teacher + Spec.	Teacher Exchange	Control Teacher Exch. + Control
CTBS					
Pure Sample					
Total Score: - Diff			+ .63		+1.05
PMA					
Pure Sample: - Diff	+8.41				+3.42
Cattell					
Pure Sample: - Diff	-1.05				+1.52
Diff			-.58		+1.52
<u>FEMALES</u>					
Raven					
Pure Sample: - Post	15.27			14.40	
Cattell					
Pure Sample: - Diff	+1.59				-.76
Diff			+.98		-.76

Table 22

Part I. Summary of Major Results [The Pure Sample]
 Showing all Interpreted Significant Sex Differences

	Peer Teacher	Spec.	Peer Teacher + Spec.	Teacher Exchange	Control	Teacher Exch. + Control
PMA Pure Sample						
Diff						
Females				+5.07		
Males				+ .75		
Females					+9.13	
Males					+3.74	
Cattell Pure Sample						
Diff						
Females	+1.59					
Males	-1.05					
Females		-.89				
Males		1.22				
Females					-1.07	
Males					1.39	

PART II

THE EFFECTS OF PEER TEACHING ON THE PEER TEACHERS THEMSELVES

Subjects and Experimental Design

The peer teachers were 21 ninth-grade students from Lowell, Roosevelt, and Wilson Jr. High Schools, and the comparisons were 22 comparable ninth graders from the same schools.

Before the experiment described herein began, special classes in mathematics were conducted by the mathematics specialists who later participated in the experiment. The students in these special classes were algebra students who showed excellence in mathematics and some propensity for peer teaching as judged by their regular teachers. The peer teachers were selected from these special classes by the math specialists who taught them and who would continue to work with them as they became peer teachers. Thus, the selection of peer teachers from the larger group was not random as we had planned, but rather depended on the choices of the math specialists and also on the individual desires of the students who were permitted to decide whether they wished to teach. The students who remained in these classes but who did not participate in peer teaching comprised the control group employed in this part of the evaluation (Part II). Further information concerning these special classes is described in Section I of this report.

The experimental design for this part of the study was a 2 x 2 factorial design in which the variables were Condition (Peer Teachers vs. Controls) and Sex. Although some peer teachers taught singly and others taught in pairs, this source of variation was not considered in their evaluation because the number of available cases was too small.

Since classrooms could not be employed as a unit for the control Ss, four groups were formed reflecting sex of Ss and condition. Dunn Contrasts were employed to determine the effects of peer teaching on the peer teachers by sex. The same measures and dependent variables which were employed in the evaluation of peer teaching were utilized to evaluate the peer teachers and their controls.

The following contrasts were performed in each analysis:

- a) male and female peer teachers vs. male and female controls
- b) male peer teachers vs. male controls
- c) female peer teachers vs. female controls

Sex differences were not analyzed because of the need to retain the maximum power for the tests which were made.

The dependent variables which were analyzed were You and School, (Total Score and individual scores for each of the six factors), CTBS (Total Score and individual scores for each of the three component scores), PMA, Raven, and Cattell.

Results: Part II

The only significant effect on the You and School total score (34 items) was for the female Ss, shown in Table 23. On the posttest, the female peer teachers' (n=12) mean score was 3.92 which was significantly higher than the female controls' (n=14) mean of 3.56. Although the means for the males were not discrepant with the results for the females, the overall comparison was not significant. None of the comparisons of the individual scales of You and School showed significant effects. However, the trend of the posttest means for all five achievement-related scales showed the peer teachers to have more favorable attitudes than the controls. The trend was also consistent for the male and female means considered separately. The peer teachers showed an insignificant trend toward higher scores on the pretest also.

None of the differences on the cognitive measures were significant. On all the CTBS measures (Tables 24 through 27) the male peer teachers tended to make greater gains than the controls. The female peer teachers, however, tended to make smaller gains than the controls. Similarly, the differences between peer teachers and their controls were not significant on the PMA, Raven, or Cattell, and there is no consistent trend to the data.

Most probably, the failure to find evidence of an effect of peer teaching on the peer teachers themselves may be attributed to a selective factor. On all of the eight major measures (Tables 23 through 30) the overall pretest scores indicate that the peer teachers were more capable (or, in the case of You and School, had more favorable attitudes toward school) than the controls. The probability of eight out of eight being in the same direction

is very low, under random selection. To the extent that this was true, the possibility of demonstrating any difference due to conditions was diminished. An evaluation of the effect of peer teaching on the peer teachers in which Ss are randomly assigned to conditions is strongly indicated. The fact that the present study failed to demonstrate any cognitive effects should not be taken as indicative of the facts because of the initial bases for selection of the peer teachers and because of the small size of the sample.

Table 23

Mean Total Score on You and School for the Peer Teachers and their Controls (n=34)

N	Posttest	Pretest	Difference
CONTROLS			
Female (14)	3.56 ^a	3.74	-.17
Male (7)	3.80	3.72	.08
Total (21)	3.66	3.73	-.07
PEER TEACHERS			
Female (12)	3.92 ^a	3.82	.10
Male (10)	3.84	3.86	-.02
Total (22)	3.88	3.84	.04

a= Significant $p < .05$.

Table 24

Mean Total Scores on the CTBS
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Post - Pretest
CONTROLS				
Female	(12)	10.08	8.10	1.98
Male	(7)	8.96	8.56	.40
Total	(19)	9.67	8.27	1.39
PEER TEACHERS				
Female	(12)	10.52	9.46	1.06
Male	(10)	10.71	9.68	1.03
Total	(22)	10.61	9.56	1.05

Table 25

Mean Scores on the Computation Scale of the CTBS
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(12)	9.69	8.27	1.43
Male	(7)	9.33	9.46	-.13
Total	(19)	9.56	8.71	.85
PEER TEACHERS				
Female	(12)	10.48	9.48	1.01
Male	(10)	10.80	9.83	.97
Total	(22)	10.62	9.64	.99

Table 26

Mean Scores on the Concepts Scale of the CTBS
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(12)	10.58	8.24	2.34
Male	(7)	9.06	8.67	.39
Total	(19)	10.02	8.40	1.62
PEER TEACHERS				
Female	(12)	10.69	9.26	1.42
Male	(10)	10.80	9.06	1.74
Total	(22)	10.74	9.17	1.57

Table 27

Mean Scores on the Applications Scale of the CTBS
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(12)	9.68	7.77	1.92
Male	(7)	8.03	7.54	.48
Total	(19)	9.07	7.68	1.39
PEER TEACHERS				
Female	(12)	9.45	9.43	.02
Male	(10)	10.04	9.51	.53
Total	(22)	9.72	9.47	.25

Table 28
Mean Scores on the PMA
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(13)	36.77	31.00	5.77
Male	(7)	40.86	29.71	11.14
Total	(20)	38.20	30.55	7.65
PEER TEACHERS				
Female	(12)	31.42	27.83	3.58
Male	(10)	47.90	40.20	7.70
Total	(22)	38.91	33.45	5.45

Table 29
Mean Scores on the Raven
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(14)	17.31	21.0	-3.69
Male	(7)	17.88	19.75	-1.88
Total	(21)	17.53	20.53	-3.00
PEER TEACHERS				
Female	(10)	17.10	20.40	-3.30
Male	(10)	18.60	21.0	-2.40
Total	(20)	17.85	20.70	-2.17

Table 30

Mean Scores on the Cattell
for the Peer Teachers and their Controls

	N	Posttest	Pretest	Difference
CONTROLS				
Female	(13)	8.92	7.53	1.38
Male	(8)	8.62	8.50	.12
Total	(21)	8.81	7.90	.90
PEER TEACHERS				
Female	(12)	9.50	8.25	1.25
Male	(10)	9.50	8.60	.90
Total	(22)	9.50	8.41	1.09

DISCUSSION

The overall results of this evaluation indicate that peer teaching, as done in Schell's program, has positive effects on cognitive performance of students taught by that method. Effects on attitudes and traits related to school achievement were small and not significant. However, the effect of this peer teaching was, in general, more beneficial to female students than to male students although the males were more responsive to the type of peer teaching and to the sex of the peer teacher than were the females.

There are numerous theoretical and practical reasons why peers may be more effective teachers than adults. Many of these are discussed and the relevant literature reviewed elsewhere (Henkin et al, 1973, Schell, 1974). First, they may be more familiar with the particular problems encountered in learning the material for the first time than adults are, and thus be better able to explain and be more patient. Second, they may serve as more effective role models than adults because they are closer in age to the students, and are therefore more readily emulated. While the peer teacher's performance is within reach, an adult may appear to be so much more competent than the seventh-grade student that it would appear unrealistic for the student to attempt to match his performance. Third, the students may admire a ninth-grade student more than they would an adult teacher, and therefore work harder to please him. Fourth, to the extent that the peer teachers are of the same social group and race as the student, they may be easier to identify with than a person with different characteristics. Fifth, the peer teachers

may be able to communicate more effectively in that they would employ a subcultural dialect which is more similar to the students' than the adult teacher's language is. Finally, observing that peer teachers receive rewards, e.g., status, money, power to grade, should serve to make them effective models. In short, the peer teacher may function more effectively than the adult teacher in that he can communicate better with the learner, he serves as a more effective role model, he may be a more effective agent for dispensing social reinforcement, and he may also be more patient.

Although our evaluation did not indicate that females were generally lower in mathematical ability and achievement than males, it is commonly found that at about the age of eleven, this trend appears and increases with age (Maccoby and Jacklin, 1974). Further, females tend not to take as many courses in math as do males and avoid occupations which require competence in mathematics. The Peer Teaching condition appeared to benefit the females particularly, and thus might well be a teaching method that should be further investigated and, if our findings are replicated, be adopted on a wider scale as a means of counteracting the usual female inferiority in mathematical abilities.

Although peer teaching in general did not benefit the males to as great an extent as the females, there was evidence that the former responded more favorably to pairs of peer teachers rather than to a peer teacher teaching alone. To the extent that peer teaching also benefits the peer teacher, it may well be advantageous to investigate this variable further with the intent of employing pairs of peer teachers in future programs of this sort. In addition, the males benefitted from having female rather than male peer

teachers, and since the only reliable benefits of peer teaching which we observed were on the female peer teachers, it would seem advantageous to encourage females to do peer teaching. It would also seem to be a reasonable way of encouraging young females to pursue any interest they have in mathematics, and as far as we can tell would be helping their male students more than male peer teachers would.

It is of some interest that the Peer Teaching condition produced reliably greater effects on computation than did the Specialist or Teacher Exchange conditions. These effects could not be due to the special math curriculum. Furthermore, the peer teachers placed no more emphasis on computation than the math specialists. It is, however, possible that the peer teachers engaged their students' participation to a greater degree, and that their students were better able to learn computation than other aspects of mathematics achievement when they were trying to learn, i.e., when they were really trying to learn, in general, computation is one of the things they learned.

In another evaluation of the Schell Peer Teaching project (Soofi, 1974), conducted during the school year, 1972-73, it was found that the peer-taught Ss' gain on the Computation Scale of the CTBS was significantly higher than other students'. Although this comparison was only made for one of the two schools under investigation, it is apparent that the gains made by those control Ss were significantly lower than would be expected from the norms, and clearly lower than the gains made by either the peer-taught group or the controls in our study. Although we merely found that the peer-taught Ss showed significantly higher posttest scores than certain of the comparison groups (Specialist and Teacher Exchange), but not the controls on the Computation Subscale, it may be said that both evaluations have produced evidence that peer-taught Ss gain more on computation than at least some control Ss.

Although Soofi (1974) concludes that project students showed larger gains than controls on the Concept Subscale of the CTBS, his levels of significance were too low to allow us to interpret this data as reliable. In addition, his conclusions are based primarily on one school. We did not obtain reliable differences among subgroups on this dependent variable either. Neither Soofi nor we found significant differences in gains on the application component of the CTBS. However, both evaluations provided evidence of greater improvement on the total CTBS scores for the peer-taught group than for certain controls. Soofi found ($p = .08$) a trend toward greater improvement on the total CTBS scores for the peer-taught group than for the controls. In the present study, the peer-taught group showed a significantly greater gain ($p < .05$) on the total scores than the Specialist and Teacher Exchange conditions, but did not show a significantly greater gain than the controls. Also, the actual gains made by the peer-taught Ss in our study were approximately one year, while in the Soofi study they only gained one-half year.

We did not investigate the students' and teachers' evaluations of peer teachers and peer teaching in a systematic way. Soofi (1974), however, found that teachers reported a positive change in motivation, attitudes toward mathematics, self confidence, etc. in most (62-75%) of their peer-taught students. The teachers also reported that most of them showed an increased participation in their math classes. Most peer-taught students reported that they were favorable toward having peer teachers and had learned "a lot" from them.

It is rather surprising that the test on which the peer-taught Ss did consistently better than Ss in the Teacher Exchange and Control conditions

was the PMA, a test of spatial imagery. Since the Peer Teaching condition combined with the Math Specialist condition also performed reliably better than the other two conditions, it is implied that the special mathematics curriculum stimulates the ability to recognize figures rotated in space. The emphasis on symbolic processes in the special curriculum used by peer teachers and specialists might perhaps stimulate the use of imagery, but there was no specific emphasis upon geometry or trigonometry.

The PMA was also the only test on which males were benefitted by peer teaching. The males in the Peer Teaching condition showed a reliably greater gain on the PMA than the males in the Teacher Exchange and Control conditions, but the females were not reliably affected differentially by the teaching conditions. In the conditions in which direct sex differences were statistically reliable, the Teacher Exchange and the Control conditions, the females showed greater gains than the males. Thus, it would appear that the special mathematics curriculum stimulated the males' spatial ability more than the females' while the Control condition stimulated the females' spatial ability more than the males'. Further analysis of the details of the curricula would be needed in order to conduct specific research to explore this phenomenon further.

It was on the Cattell test of concept formation, however, that the females exhibited the large and consistent positive benefits from peer teaching. The effect was quite consistent in that the peer-taught females also showed a significantly more positive benefit than the peer-taught males, while they showed significantly less benefit than the males in the Specialist and Control conditions. Similar benefits to females were also observed on the Raven. Apparently, peer teaching facilitates concept formation in females, compared with other teaching methods. Although this evaluation

provided some evidence of sex differences in response to teaching method and curriculum, further research is clearly required in order to establish these suggestive relationships.

No attempt was made in the present study to compare the performance of the peer teachers with that of the students whom they teach. In studies of tutoring, it has been observed repeatedly (Gartner, Kohler, and Riessman, 1971; Henkin et al, 1973) that the tutor's gains far exceed that of the tutee. If in fact tutoring facilitates the learning of the subject being taught, peer teaching should have a similar effect. None of the tutoring studies were done with a control group of students of comparable ability who did not tutor. Our study attempted to do this, but due to our inability to randomly assign students to conditions, our peer teachers and their controls were not matched for ability and attitudes at the outset. However, if the effects of peer teaching on the peer teacher were as large and significant as one is led to expect from the tutoring literature, we should have found significant differences between the groups anyway. But, we did not observe any consistent trends and none of the cognitive measures showed a reliable effect. The only significant effect was that the female peer teachers showed more positive attitudes toward school achievement than the controls. In short, we are concerned that the reported benefits of peer tutoring are not nearly as large and consistent as presently believed, but that the effect is due to a selective bias in which the higher ability Ss are doing the tutoring and therefore show greater gains. Systematic investigation of this issue is now demanded, with the use of random assignment of Ss to conditions and the employment of both same-age and cross-age controls.

It would be particularly useful to replicate the present evaluation with a larger number of cases in the Specialist and Teacher Exchange condition. In addition, systematic observation of classroom teaching and student response would be most helpful in pinpointing the source of the benefits of peer teaching. Some pilot work along these lines was done in the present study, but resources were not available to investigate the classrooms systematically. A survey of student and teacher evaluation of the particular math classes in the evaluation would also be helpful.

Further research is clearly needed to document the suggestions and findings of the present study concerning the differential impact induced by varying the type of peer teaching and the sex of the peer teacher. Since these factors were found to have definite relevance to the performance of male students and are important in designing future peer teaching programs, support of such research is readily justified.

REFERENCES: PART II

- Dunn, O. Multiple comparisons among means. Journal of the American Statistical Association, 1961, 56, 42-64.
- Gartner, A., Kohler, M., and Riessman, F. Children Teach Children, NY: Harper & Row, 1971.
- Henkin, L., Amster, H., and Schell, L. Experimental Investigation of Peer Teaching. Proposal submitted to NIE, 1973.
- Maccoby, E. and Jacklin C., The Psychology of Sex Differences, Stanford U. Press, 1974.
- Schell, L., Final Project Report on the Program: Project APT - Educational Alternatives through Peer Teaching. NSF-CCSS Grant: NSF-GW-6548, 1974.
- Soofi, E.S., Some effects of peer teaching on the students, the relation of its motivational and achievement effects. M.S. thesis, University of California, Berkeley, 1974.